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Estimating Commercial Product Potential in Small-Stem Lodgepole Pine: Methods, Products, Values

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RESEARCH SUMMARY

Managers need a procedure to assess commercial potential in small-stem stands, using conventional stand table or cruise plot information. This report describes a system that predicts merchantable length and potential product recovery using diameter at breast height (d.b.h.) and total height for lodgepole pine trees in 3- through 7-inch d.b.h. classes.

Results of the research include tables of alternative gross product mixes by d.b.h. class, product mix and defect information for nine representative small-stem lodgepole pine stands, and general computer routines. A computer routine enables the user to define a maximum of seven products and obtain product alternatives for each d.b.h. class. If the user has only stand table information available, a second routine evaluates gross product potential based on the user's selected product alternatives. If the user has individual tree records (including defect data), net product potential can be obtained from a third routine.

Users have the option of applying the product information developed for one of the nine representative stands that has characteristics similar to the stand they are evaluating. Users also have the option of selecting their own products to generate alternative product mixes.

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LODGEPOLE MANAGEMENT NEEDS

Those who manage lodgepole pine stands in the Rocky Mountain West are faced with a major problem: How to achieve multiple-resource management in stands of small-stem, low-value trees. Harvesting merchantable forest products is generally the principal means for meeting objectives not only for timber production but also for other forest resources. Consequently, an important management function is to identify merchandising opportunities, alternatives, and product values. Specific knowledge of the kinds, quantities, and values of merchantable products that can be recovered from a stand will enhance the management planning process.

Product recovery from similar stands in the vicinity may be helpful. But these are not always true indicators of product potential because individual operators are strongly influenced by personal preference, equipment limitations, and market constraints. Forest managers need a method for predicting total product potential in small-stem stands using conventional stand-table or cruise plot information. Also important is the identification of various products or combinations of products and their values recoverable from a stand.

To satisfy this need, we developed a system that enables managers to accurately predict potential of a stand to produce various combinations of common small-diameter roundwood products. Estimates of the gross product potential can be reduced to realistic net estimates based on observed tree defects in the stand. We hope this method will be useful to both land managers and logging contractors in evaluating economic feasibility of specific stands. The ability to identify product potential and maximize value recovery may make the difference between treating and not treating stands that are of questionable profitability.

We had to meet four major objectives to provide maximum flexibility in our product prediction process.

1. Develop a method for estimating gross product potential for a stand from a stand table. This method requires only the availability of a stand table for the timber being examined, and uses average total tree height in each diameter class.
2. Develop a method for estimating gross product potential for a stand from individual tree data, where detailed cruise plot records are available describing individual sample trees.
3. Develop a method for reducing gross product potential to net potential for stands that have individual tree defect data available.
4. Apply gross and net product prediction methods based on individual tree records (items 2 and 3) to nine selected sample stands representing a broad range of tree size and stand density. Describe these stands sufficiently to allow direct comparison with stands of interest to managers, as an alternative to analyzing stand data.

The study approach defined by these objectives was purposely chosen to accommodate a wide range of available stand information. Information available to the manager may vary from detailed individual tree cruise data to aggregate stand table information, or perhaps only a general knowledge of the character of the stand. Objectives 1, 2, and 3 are directed toward providing methods that can effectively use individual tree or stand table information, while objective 4 is concerned with providing actual product information for sample stands which may then be compared to stands of interest.

DEVELOPING THE PREDICTION SYSTEM

Prediction system development made use of stand and tree data accumulated from 19 sample lodgepole pine stands geographically dispersed from the Wasatch-Cache National Forest (Utah-Wyoming) to the Lewis and Clark National Forest (north-central Montana). All stands were essentially pure lodgepole pine, ranging in stand density from 1,000 to 7,000 green stems per acre, and in diameter from 3 to 7 inches d.b.h. They are broadly representative of the extensive overstocked, small-stem lodgepole pine stands occupying several million acres in the Inland West.

Stem Profile Table

The number and kind of roundwood products that can be obtained from a tree are determined by the profile of the stem—butt diameter, rate of taper and upper stem diameters, and length to some minimum usable diameter. As a basis for assessing product potential, we first developed a table of stem profiles that represented the range of tree diameter and height classes encountered on study sites.

An initial question was whether tree d.b.h. and total height alone could explain variation in "merchantable" stem length to various top diameters. We analyzed tree dimension data from the Montana and Utah/Wyoming sites separately, using stepwise regression methods to examine a number of independent variables, including tree d.b.h., total height, stand density, age, and site index. The analyses indicated that d.b.h. and total height were the only variables needed to predict stem length to specified top diameters. Density, age, and site effects are adequately reflected in the diameter-height relationship, and do not have to be accounted for separately. Any one stem d.b.h./height class can therefore be represented by a single stem profile, regardless of stand location or characteristics. Data from the Montana and Utah/Wyoming sites, totaling 341 destructively sampled trees, were consequently pooled to develop regressions predicting stem length to specified top diameters for lodgepole pine trees from 3 to 7 inches d.b.h.

The next step was validation. A second sample of 103 trees was selected from seven of the study stands to cover the range of each d.b.h. class of interest. For example, in the 3-inch class (2.6 to 3.5 inches) in each stand one tree was chosen with d.b.h. between 2.6 and 2.8 inches, one with d.b.h. between 2.9 and 3.2 inches, and one with d.b.h. between 3.3 and 3.5 inches. The selected sample trees were felled, and diameters were recorded at various heights up the stem. Comparisons of measured profiles for these sample trees with predicted profiles from the original stem length regression equations showed a high correlation.

The final step was to combine the original sample (341 trees) with the validation sample (103 trees) and recalculate stem length regression equations. Table 1 shows the resulting predicted stem length to specified top diameters for various d.b.h. and total height combinations. The regressions and tabled values are based on the total sample of 444 felled and measured trees from all 19 sample stands. The stem profiles described by the regressions and table should be representative of all lodgepole pine trees in the diameter and height classes shown.

Product Specifications and Values

Our intent was to develop a procedure that would predict product potential in terms of some common small-diameter products currently utilized by industry operators in the Northern and Central Rocky Mountain area. The product specification search revealed a large number of roundwood products, with length and diameter requirements varying among manufacturers—and virtually no industry standardization. For example, one post and pole yard makes 37 different post products, in addition to a variety of pole and sawed products.

A few products, however, are relatively standardized and represent the range of products and values the average operator might recover. Table 2 lists seven such products, with lengths, minimum and maximum small-end diameters, and values per piece as well as per cubic foot. Values are an amalgamation of prices paid for raw material delivered to manufacturing points early in 1984.

Table 1—Stem profile table for lodgepole pine, indicating length to specified top diameters, by total height and diameter at breast height (d.b.h.) classes

Total height	Top diameter[1]	Diameter at breast height (inches) 3	4	5	6	7
Feet	*Inches*			*Feet*		
25	3	4	10			
	2	15	18			
30	4		4	10		
	3	4	13	18		
	2	19	22	24		
35	5			4	11	
	4		4	13	20	
	3	4	17	22	27	
	2	23	26	28	31	
40	5			4	14	22
	4		4	16	23	29
	3	4	21	26	30	35
	2	27	30	33	35	38
45	5			4	16	25
	4		4	19	26	32
	3	4	25	29	34	39
	2	31	34	37	39	42
50	5			4	19	27
	4		4	24	29	36
	3	4	28	33	38	42
	2	36	38	41	43	46
55	5			4	21	30
	4		4	26	32	39
	3		32	37	41	46
	2		42	45	48	50
60	5					32
	4					42
	3					50
	2					54

[1]Regression equations used (for top diameters less than d.b.h.):

Top diameter	Predicted length	R^2	se
2	−13.685 + 2.64 (d.b.h.) + 0.826 (hgt)	0.92	2.35
3	−27.687 + 4.698 (d.b.h.) + 0.744 (hgt)	.87	3.14
4	−40.979 + 6.51 (d.b.h.) + 0.619 (hgt)	.85	3.31
5	−56.613 + 8.233 (d.b.h.) + 0.522 (hgt)	.71	3.86

Alternative Gross Product Mixes

Using the stem profile table and the seven specified roundwood products, we developed a system to generate a matrix of all possible gross product alternatives for a tree of specified d.b.h. and height. This may be either the average tree in a d.b.h./height class if a stand table is being used as input data, or the d.b.h. and height class of individual sample trees if individual tree records are

Table 2—Product specifications and values for selected roundwood products commonly recovered from lodgepole pine

Product	Length	Small-end diameter Minimum	Small-end diameter Maximum	1984 value[1] Per piece	1984 value[1] Per ft³
	Feet	----- *Inches* -----		- - -*Dollars* - - -	
Post	7	4	7	0.52	0.54
Rail	13	3	5	.65	.49
Rail	17	3	5	1.24	.67
Rail	21	3	5	1.45	.59
Prop	10	2.25	4	.50	.83
Panel pole	17	2	2.5	.50	.86
Barn pole	17	6	7	2.38	.62

[1]Prices paid for raw material f.o.b. manufacturing points.

used. Based on observations of the physical characteristics of small-stem lodgepole pine, certain standard operating rules were established. These constraints included taking 1 foot off the butt end of the tree to avoid butt swell, requiring that props and panel poles come only from the 3- and 4-inch d.b.h. classes (avoiding limby tops), and searching for barn poles only in the 7-inch d.b.h. class. We further specified a minimum "merchantable" top diameter, above which products would not be recovered, for each d.b.h. class:

D.b.h. class	Minimum top diameter
3 and 4	2 inches
5 and 6	3 inches
7	4 inches

To compensate for the fact that trees do not taper uniformly, and also to simplify the computations, an average taper was calculated for each d.b.h. and height. These tapers were derived as averages of whole tree taper to the minimum top diameter and taper in a specified lower segment. The general formula used for taper is given by:

$$\text{taper} = \frac{\text{d.b.h.} - D}{L - 1}$$

For whole tree taper, D is the minimum top diameter given above. For the specified lower segment we used:

D.b.h. class	D
4	3
5	4
6	5
7	5

In both cases, the length L is obtained from table 1 and then 1 foot is subtracted for butt swell. The two tapers coincide for the 3-inch d.b.h. class.

Alternative gross product mixes, residual stem volumes, and tree values for a range of total height classes were developed for the 3- through 7-inch d.b.h. classes (appendix A, tables 3 through 7). Residual volume is the unutilized cubic foot volume to the defined minimum top diameter.

The matrix of alternatives for a particular diameter/height class can be used to pick the product combination that will maximize value. Or, an alternative with desired products can be selected. In this paper, the alternative to maximize value has been used.

Adjusting for Defect

The estimation of gross product potential ignores the possible presence of defect in trees. If limiting or inadmissible defects are present in the stem or stand, actual product recovery will obviously be reduced. As part of this study, we examined alternatives for using individual tree defect data to adjust gross-to-net product potential.

Based on experience with local operators and a survey of manufacturing operations, we defined seven types of defect that influence product recovery. These were crook, fork, fire scar, catface, knot cluster, mistletoe or canker swell, and sweep. Instructions for stem defect sampling are detailed in appendix B. We also developed criteria to assess the effects of defect occurrence on product potential.

Defect analysis was based on individual tree data collected from 1,817 sample trees on nine of the study sites. The exact location of each defect in the stem was recorded, as well as the length of stem affected by the defect. These defective lengths were then deducted from the stem and the remaining stem segments searched for products.

Summaries of the defect occurrence found in each of the nine sample stands are given in appendix C. The percentage of stems with 0, 1, or 2+ defects, as well as the percentage of stems with defects located within each quarter of the merchantable stem length, are reported by d.b.h. class.

Adjustment of potential product recovery to account for defect requires either defect information for individual trees, as was collected for these nine stands, or a "defect factor" based on general experience. To adjust both the product mix recoverable and the value requires individual tree data. A "defect factor" can be applied only as an adjustment to total recovery and value.

APPLICATIONS OF THE METHOD

Managers have three alternatives for predicting product potential, depending on the stand information available. Cruise data for individual sample trees allow direct estimation of gross product potential, tree by tree, as well as reduction to net potential if tree defect information also exists. If information is limited to an aggregate stand table, gross product potential can be estimated using it alone. And if neither sample tree data nor stand table data exist, a manager can simply use the gross and net product potential information developed for a sample stand that most nearly matches the stand of interest.

Gross Product Potential From a Stand Table

To estimate the gross product potential from a stand table, one must know the average total height of trees in each d.b.h. class. This identifies the set of alternative gross product combinations from which one alternative

can be chosen for the diameter class. The number of products in the chosen alternative is then multiplied by stems per acre to give predicted gross products per acre for that diameter class. Aggregation of products for all diameter classes indicates total stand product potential per acre.

Appendix C shows stand descriptions that include stand tables for each of the nine sample stands. Gross product estimates are also presented for the product combination that maximizes value in each diameter class.

Gross and Net Product Potential From Individual Tree Data

Individual tree cruise data that include defect information provide the most reliable basis for product prediction. To demonstrate the use of individual tree data, we used the nine sample stands selected to represent typical stand conditions in small-stem lodgepole pine. Six to nine 1/100-acre plots were established in each of these stands. Defect was identified and measured in all trees with at least a 3-inch d.b.h., as previously described. Using individual tree d.b.h. and total height, the value-maximizing product combination from the matrix of alternatives was used to obtain gross product potential, with the assumption that each sample tree was free of defect. To determine net product potential, individual trees were searched for products after all defective portions were eliminated.

The gross and net product estimates resulting from aggregation of individual tree records for each of the nine sample stands are shown in appendix C. These tables also give the unutilized volume to the minimum top diameter, the product value for each d.b.h. class, and total stand value. The reduction in predicted total stand value due to defect ranged from 16 to 46 percent. Product mixes changed and net residual (unused) volume increased. As expected, net values are less than gross values except in a few instances where a specific d.b.h. class had no defect.

Figures 1 to 3 (appendix C) illustrate the gross and net values for the nine sample stands and also show trees per acre. These figures characterize each of the stands in terms of value and defect distribution by d.b.h. class. For example, Ballard Hill South in figure 1 shows that value is concentrated in the 6- and 7-inch d.b.h. classes; Corduroy Creek East in figure 2 shows that the greatest reductions due to defect are in the 3- and 4-inch d.b.h. classes. Some differences may be large, partly because of reductions in the number of products made and partly because of higher valued products being replaced by lower valued products.

Product Potential by Comparing Stands

The nine stands for which gross and net product potential have been calculated, based on individual tree data, represent a wide range of stand conditions. In the absence of specific stand table or cruise data, or as a matter of expediency, a manager can simply use product information for one of these stands that most nearly matches a stand of interest. Important stand comparison criteria are size class distribution of stems, stand density, and defect occurrence. If a stand is similar in these respects to one of the nine stands analyzed, the product potential should also be similar.

Managers may also have stand information—a stand table, for example—that allows estimation of gross product potential, but no information describing defect in the stand. Comparison with one of the nine sample stands provides a way of choosing a "defect factor" or value reduction factor that can be used to adjust gross product potential.

THE COMPUTER ROUTINES

Three computer routines are presented here for use in applying our methodology (appendix D). These programs are written in standard FORTRAN 77 and have been run on the Forest Service Data General system and on a minicomputer in Missoula. A software package is not available, but program documentation is as complete as possible. Minimal programming changes should allow running the routines on a wide variety of computers.

The choice of routines to be used will depend on needs and available information. One program allows the user to specify different products and values in order to obtain product alternatives consistent with particular utilization objectives. When only stand table information is available, a second program will give gross product estimates based on the user's selected product alternatives. If the user has cruise plot records describing individual trees and their defects, the net product estimates can be obtained from a third program.

To Obtain Gross Product Alternatives

This routine gives the user the option to define a maximum of seven products. Length and diameters for the small end and large end, as well as value, must be entered by the user for each product. The user is queried for this information at run time. The program output is a set of tables showing alternatives by tree d.b.h. and total height for the chosen products (similar to the tables displayed in appendix A). Sometimes alternatives are redundant because the program does not check for that. The user needs to look over the listing. Redundancies have been deleted from the tables in appendix A.

The user needs to be aware that the order in which products are entered will affect the output. Also, the user should keep in mind that this program gives an approximation. Expected alternatives sometimes do not appear. In spite of these drawbacks, the program can be a useful tool.

To Obtain Gross Estimates From a Stand Table

This program requires stand table information. In addition, a set of product alternatives must be chosen. These could be based on products selected by us or on products selected by the user. The product alternative data are entered at run time. A worksheet is given

following program 2 (appendix D) to assist the user. The output gives an evaluation of product mixes and values by d.b.h. class for the particular stand.

To Obtain Net Estimates

This program requires information describing individual tree pieces after any defective portions have been removed. The user must provide a data file containing this information. Details on the contents of this file are given at the end of program 3 (appendix D). Also, a set of product specifications and values (as shown in table 2) is needed; this information is entered at run time. The output gives product mixes and values for only the trees in the stand containing defects. This output needs to be combined with the products obtained from the trees completely free of defect. For trees free of defect, the chosen product alternative will provide the product mix and value.

MANAGEMENT IMPLICATIONS

Major results of our study include the stem profile table, tables of gross product mixes for our defined group of products, and product prediction results for the nine sample stands. This information can be of value to anyone who is working with comparable products and stands. Of particular importance is the computer routine that generates alternative gross product mixes for user-specified products.

These methods are useful to anyone who needs to identify merchandising opportunities, alternatives, and values. They can be used to enhance land management planning and to facilitate financial decisions. Land managers, appraisers, and forest products firms will find this procedure useful for evaluating stands in terms of currently marketable products. Others, such as entrepreneurs, economists, or consultants, may use this technique to analyze stand potential based on a variety of theoretical product and price combinations. In any case, a user can tailor the process by defining appropriate product specifications, values, and defect criteria.

A practical application of these methods would be an entrepreneur who has developed a use for a high volume of small-stem lodgepole pine of specific dimensions and quality. This raw material is available for purchase on a per-acre basis in conjunction with a prescribed stand treatment. To assess recovery and value per acre, the entrepreneur will want to know the volume of preferred products that can be generated as well as the volume and value of additional products that might be salvaged and sold. This evaluation can be achieved by entering user-defined product specifications and values into the computer program and then searching for a product combination alternative that maximizes the preferred product. Such analysis could be based on intensive field sampling of proposed sale areas or on extensive sampling of representative stand types. Individual tree records and detailed defect data from cruise plots will provide the most reliable results. But a useful analysis might also be made from available stand table information.

APPENDIX A: ALTERNATIVE GROSS PRODUCT MIXES AND VALUES

This appendix displays tables of alternative gross product combinations for the 3- through 7-inch d.b.h. classes of lodgepole pine (tables 3-7). The unutilized cubic foot volume to the defined minimum top diameter for each class is given in the column headed "residual." The values shown are 1984 values (see table 2).

Table 3—Alternative gross product mixes and values for the 3-inch d.b.h.class of lodgepole pine

Total height	Alternative	10-foot prop	Panel pole	Residual volume	Value
				Ft^3	
25	1	1	0	0.11	$0.50
30	1	1	0	.23	.50
	2	0	1	.03	.50
35	1	1	0	.36	.50
	2	0	1	.13	.50
40	1	1	0	.49	.50
	2	0	1	.25	.50
45	1	1	1	.09	1.00
50	1	1	1	.23	1.00
	2	0	2	.05	1.00

Table 4—Alternative gross product mixes and values for the 4-inch d.b.h. class of lodgepole pine

Total height	Alternative	13-foot rail	17-foot rail	21-foot rail	10-foot prop	Panel pole	Residual volume	Value
							Ft^3	
25	1	0	0	0	1	0	0.27	$0.50
30	1	0	0	0	1	0	.45	.50
35	1	1	0	0	1	0	.05	1.15
	2	0	0	0	2	0	.16	1.00
	3	0	0	0	0	1	.53	.50
40	1	1	0	0	1	0	.18	1.15
	2	0	1	0	1	0	.03	1.74
	3	0	0	0	2	0	.30	1.00
	4	0	0	0	1	1	.03	1.00
45	1	1	0	0	2	0	.00	1.65
	2	1	0	0	0	1	.04	1.15
	3	0	1	0	1	0	.15	1.74
	4	0	0	0	3	0	.05	1.50
	5	0	0	0	1	1	.21	1.00
50	1	1	0	0	2	0	.08	1.65
	2	1	0	0	0	1	.23	1.15
	3	0	1	0	2	0	.00	2.24
	4	0	1	0	0	1	.03	1.74
	5	0	0	1	1	0	.14	1.95
	6	0	0	0	3	0	.19	1.50
	7	0	0	0	2	1	.00	1.50
55	1	1	0	0	2	0	.21	1.65
	2	1	0	0	1	1	.00	1.65
	3	1	0	0	0	1	.46	1.15
	4	0	1	0	2	0	.06	2.24
	5	0	1	0	0	1	.21	1.74
	6	0	0	1	1	0	.28	1.95
	7	0	0	1	0	1	.01	1.95
	8	0	0	0	3	0	.37	1.50
	9	0	0	0	2	1	.06	1.50

Table 5—Alternative gross product mixes and values for the 5-inch d.b.h. class of lodgepole pine

Total height	Alternative	7-foot post	13-foot rail	17-foot rail	21-foot rail	Residual volume	Value
						Ft^3	
30	1	1	0	0	0	0.77	$0.52
	2	0	1	0	0	.26	.65
	3	0	0	1	0	.00	1.24
35	1	1	1	0	0	.06	1.17
	2	0	0	1	0	.23	1.24
	3	0	0	0	1	.00	1.45
40	1	2	0	0	0	.78	1.04
	2	1	1	0	0	.31	1.17
	3	1	0	1	0	.04	1.76
	4	0	0	0	1	.20	1.45
45	1	2	1	0	0	.03	1.69
	2	1	0	1	0	.21	1.76
	3	1	0	0	1	.00	1.97
	4	0	2	0	0	.08	1.30
50	1	2	1	0	0	.24	1.69
	2	2	0	1	0	.00	2.28
	3	1	0	0	1	.15	1.97
	4	0	2	0	0	.30	1.30
	5	0	1	1	0	.03	1.89
55	1	3	1	0	0	.05	2.21
	2	2	0	1	0	.24	2.28
	3	2	0	0	1	.00	2.49
	4	1	2	0	0	.11	1.82
	5	0	1	1	0	.30	1.89
	6	0	1	0	1	.03	2.10
	7	0	0	2	0	.03	2.48

Table 6—Alternative gross product mixes and values for the 6-inch d.b.h. class of lodgepole pine

Total height	Alternative	7-foot post	13-foot rail	17-foot rail	21-foot rail	Residual volume	Value
						Ft^3	
35	1	2	0	0	0	1.08	$1.04
	2	1	1	0	0	.48	1.17
	3	1	0	1	0	.17	1.76
	4	0	2	0	0	.06	1.30
	5	0	0	0	1	.33	1.45
40	1	3	0	0	0	.60	1.56
	2	2	1	0	0	.11	1.69
	3	1	0	1	0	.31	1.76
	4	1	0	0	1	.00	1.97
	5	0	2	0	0	.16	1.30
45	1	3	0	0	0	.97	1.56
	2	2	1	0	0	.40	1.69
	3	2	0	1	0	.08	2.28
	4	1	2	0	0	.00	1.82
	5	1	0	0	1	.28	1.97
	6	0	1	1	0	.14	1.89
50	1	4	0	0	0	.62	2.08
	2	3	1	0	0	.11	2.21
	3	2	0	1	0	.34	2.28
	4	2	0	0	1	.01	2.49
	5	1	2	0	0	.18	1.82
	6	1	1	1	0	.00	2.41
	7	0	1	0	1	.19	2.10
	8	0	0	2	0	.20	2.48
55	1	4	0	0	0	.87	2.08
	2	3	1	0	0	.32	2.21
	3	3	0	1	0	.00	2.80
	4	2	2	0	0	.00	2.34
	5	2	0	0	1	.21	2.49
	6	1	1	1	0	.07	2.41
	7	0	1	0	1	.62	2.10
	8	0	0	2	0	.63	2.48
	9	0	0	1	1	.30	2.69

Table 7—Alternative gross product mixes and values for the 7-inch d.b.h. class of lodgepole pine

Total height	Alternative	7-foot post	13-foot rail	17-foot rail	21-foot rail	Barn pole	Residual volume	Value
							Ft^3	
40	1	4	0	0	0	0	0.10	$2.08
	2	2	1	0	0	0	.18	1.69
	3	1	0	1	0	0	.72	1.76
45	1	4	0	0	0	0	.39	2.08
	2	2	1	0	0	0	.49	1.69
	3	2	0	1	0	0	.05	2.28
	4	2	0	0	0	1	.05	3.42
	5	0	1	0	0	1	.13	3.03
	6	1	0	0	1	0	.73	1.97
50	1	5	0	0	0	0	.15	2.60
	2	3	1	0	0	0	.23	2.21
	3	2	0	1	0	0	.52	2.28
	4	2	0	0	1	0	.09	2.49
	5	2	0	0	0	1	.52	3.42
	6	0	1	0	0	1	.62	3.03
	7	0	0	1	0	1	.18	3.62
55	1	5	0	0	0	0	.43	2.60
	2	3	1	0	0	0	.53	2.21
	3	3	0	1	0	0	.10	2.80
	4	2	0	0	1	0	.38	2.49
	5	3	0	0	0	1	.10	3.94
	6	1	1	0	0	1	.19	3.55
	7	0	0	1	0	1	.48	3.62
	8	0	0	0	1	1	.05	3.83
60	1	5	0	0	0	0	.78	2.60
	2	4	1	0	0	0	.14	2.73
	3	3	0	1	0	0	.42	2.80
	4	2	0	0	1	0	.90	2.49
	5	3	0	0	0	1	.42	3.94
	6	1	1	0	0	1	.52	3.55
	7	1	0	1	0	1	.10	4.14
	8	0	0	0	1	1	.38	3.83
	9	2	2	0	0	0	.47	2.34

APPENDIX B: SAMPLING STEM DEFECT

The following section describes a procedure for sampling stem defect that will yield the data needed to calculate net product potential. This section includes definitions of primary defects and instructions for measuring them. A field form is also offered, along with defect codes and code descriptions.

Defect should be observed and recorded for all trees 3 inches and larger in d.b.h. on plots located in the stand of interest. We used 1/100-acre plots (11.8-foot radius) systematically distributed across the stand, with six to nine plots per stand.

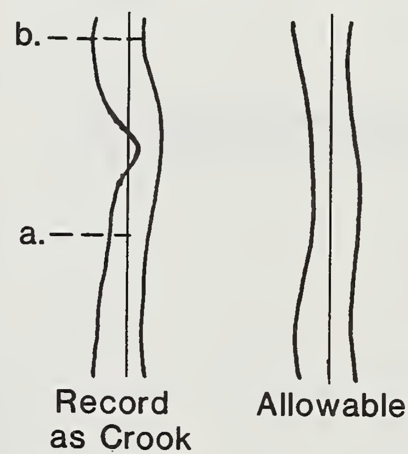
Each defect (trees may have multiple defects) should be observed and measured in the primary stem of each plot tree 3+ inches d.b.h., to a minimum top diameter as follows:

D.b.h. class	Minimum top diameter *Inches*
3-4	2
5-6	3
7+	4

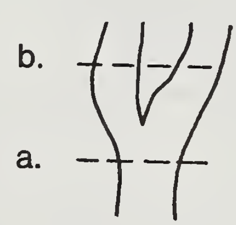
Defects Observed

The defects observed and measured in each sample tree include the following:

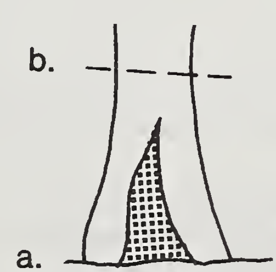
CROOK: A localized stem deviation that is severe enough (equal to or exceeds half the stem diameter) to require bucking out.



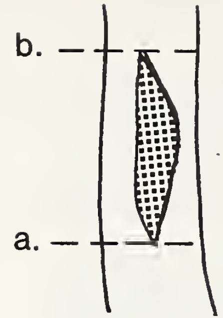
FORK: A more or less equal division of the primary stem.



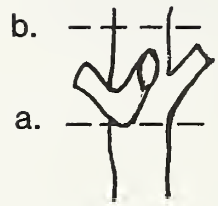
FIRE SCAR: Usually basal, flattened, with char, rot, or exposed wood. Exposed or distorted wood is a defect.



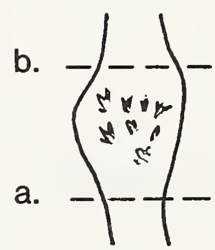
CATFACE: Scar on the bole resulting from fire, earlier nonlethal beetle attacks, falling snags, or other physical damage. Significant exposed wood constitutes a defect.



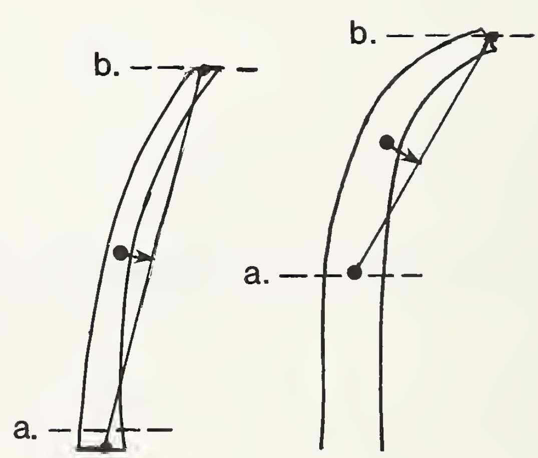
KNOT CLUSTER: A concentration of limbs within a 1-foot stem section, such that the section would require bucking out (generally associated with abnormal growth, witches broom, etc.).



MISTLETOE OR CANKER SWELL: An abnormal swelling with accompanying canker or mistletoe sprouts evident.



SWEEP: A gradual curvature of either the entire merchantable stem, or some major portion of the stem, exceeding allowable limits for roundwood products—generally, centerpoint deviation exceeding the diameter of the stem.



Because trees will not be felled, defects are observed from the ground. A collapsible measuring pole is useful to measure height (to nearest tenth of a foot) to defects in the first 30 feet of the bole. Heights should be measured **from groundline** to points a. and b., representing the portion of the stem that would not be usable for conventional post and pole products.

Point a. and b. measurements for defects within the merchantable stem above 30 feet can be estimated, using the pole as a reference.

Base of the live crown is indicated on the field form and is optional. Defect codes, specific tree data requirements, plot identification, and so forth are also given on the field form.

Lodgepole Pine Defect Field Form

Page ______ of ______

Measured by: ____________________

Stand name: ____________________

Measurement date			Region	Forest	District	Stand	Treatment	Plot
XX	XX	XX	X	X	X	XX	X	XX
Month	Day	Year	Code	Code	Code	Number	Number	Number

Tree number XX	D.b.h. XX.X	Base live crown XX	Total tree height XX	Defect bottom height XX.X	Defect top height XX.X	Defect code X	Observer notes 1/100-acre plots (11.8-foot radius)

NOTE: All heights are measured from ground line. Base of live crown and total tree height are measured to the nearest foot; bottom and top of defects to the nearest half foot.

Minimum merchantable diameters:

2.6-2.8	2.9-3.2	3.3-3.5	=	2-inch top
3.6-3.8	3.9-4.2	4.3-4.5	=	2-inch top
4.6-4.8	4.9-5.2	5.3-5.5	=	3-inch top
5.6-5.8	5.9-6.2	6.3-6.5	=	3-inch top
6.6-6.8	6.9-7.2	7.3-7.5	=	4-inch top

Defect codes: 1 = crook; 2 = fork; 3 = fire scar; 4 = catface; 5 = knot cluster; 6 = swell; 7 = sweep; 8 = other.

Defect Code Definition

CODE NUMBER

1 = CROOK: Localized stem deviation severe enough (equal to or exceeds half the stem diameter) to require bucking out.

2 = FORK: A more-or-less equal division of the central stem.

3 = FIRE SCAR: Usually basal, flattened, with char, rot, or exposed wood. Exposed or distorted wood is a defect.

4 = CATFACE: Scar on the bole resulting from falling snags or other physical damage. Significant exposed wood constitutes a defect.

5 = KNOT CLUSTER: A concentration of limbs within a 1-foot stem section, would require bucking out (generally associated with abnormal growth, witches broom, etc.).

6 = MISTLETOE OR CANKER SWELL: An abnormal swelling, with evident canker or mistletoe sprouts.

7 = SWEEP: A gradual curvature of either the entire merchantable stem, or some major portion of the stem, exceeding allowable limits for roundwood products—generally, centerpoint deviation exceeding the diameter of the stem.

8 = OTHER DEFECT: Details should be explained in notes on field sheets.

APPENDIX C: DESCRIPTIONS AND SUMMARIES FOR NINE SAMPLE STANDS

This appendix provides narrative descriptions and tabular summaries for nine sample stands to which the product prediction methods have been applied. Each stand description includes a tabulated stand inventory followed by three tables: gross product estimates based on the stand table, a summary of defect occurrence, and gross/net product estimates developed from individual sample tree records. Figures 1-3 at the end of the appendix allow a visual comparison of the stands.

Ballard Hill North

STAND DESCRIPTION

Location—This unit is located on the Deerlodge Ranger District of the Deerlodge National Forest, in T. 8 N., R. 11 W., sec. 4, Montana Principal Meridian. The unit is approximately 10 miles south of Gold Creek, MT, via Gold Creek Road (No. 636) and Ballard Hill Road (No. 5168).

Physical Features and Climate—This stand is located on 10- to 30-percent slopes on a northeast-facing aspect at an elevation of 6,300 feet. Local relief is characterized by straight or convex linear slope shape. Mean annual precipitation is 20 inches, as estimated from SCS precipitation maps. Mean annual temperature (30-year normal) for nearby Philipsburg is 41 °F, with July normals of 61 °F and January normals of 21 °F.

Vegetation—This is an 80-year-old lodgepole pine stand having a site index of 94. Habitat type for this stand is *Abies lasiocarpa*/*Linnaea borealis*-*Linnaea borealis* phase. The dominant seral species is *Pinus contorta*. The understory is dominated by *Vaccinium globulare, V. scoparium, Arnica latifolia, A. cordifolia,* and *Chimaphila umbellata. Goodyera oblongifolia, Linnaea borealis,* and *Xerophyllum tenax* are common. *Spiraea betulifolia, Lonicera utahensis,* and *Arctostaphylos uva-ursi* are present infrequently. Pinegrass is expected but not found in our samples.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on seven 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	39.8	1,000	1,070
4	47.0	786	1,737
5	52.5	400	1,520
6	57.0	157	920
7	60.9	57	479

SUMMARIES (TABLES 8-10)

Table 8—Gross product estimates per acre for the Ballard Hill North sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	*Number*							*Ft³*	
3						1,000		250.00	$ 500.00
4			786		786			117.90	1,367.64
5	800			400				0.00	996.00
6	471		157					0.00	439.60
7	57		57				57	5.70	235.98
Total									$3,539.22

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 9—Summary of defect occurrence for the Ballard Hill North sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	*Percentage of stems*							
3	47	42	11	35	7	7	13	1
4	47	38	15	27	9	18	11	4
5	54	39	7	29	7	14	4	0
6	73	27	0	18	9	0	0	0
7	75	25	0	25	0	0	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 10—Gross and net product estimates per acre for the Ballard Hill North sample unit, using individual tree records as a basis for prediction

D.b.h. class		Products[1]							Residual volume	Value
		1	2	3	4	5	6	7		
Inches		*Number*							*Ft³*	
3	Gross					186	871		113.54	$528.50
	Net					200	671		220.01	435.50
4	Gross		200	486		915			83.59	1,190.14
	Net		157	257		815	100		234.14	878.23
5	Gross	643		200	200				0.56	872.36
	Net	614	14	243	100				125.85	774.70
6	Gross	400		114	43				1.41	411.71
	Net	371		71	86				18.78	405.66
7	Gross	100		29				57	5.00	223.62
	Net	100		28				57	11.07	222.38
Total										
	Gross									$3,226.33
	Net									$2,716.47

Reduction in total value due to defect = 15.8 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Ballard Hill South

STAND DESCRIPTION

Location—This unit is located on the Deerlodge Ranger District of the Deerlodge National Forest, in T. 8 N., R. 11 W., sec. 4, Montana Principal Meridian. The unit is approximately 10 miles south of Gold Creek, MT, via Gold Creek Road (No. 636) and Ballard Hill Road (No. 5168).

Physical Features and Climate—This stand is located on 10- to 30-percent slopes on a northeast-facing aspect at an elevation of 6,300 feet. Local relief is characterized by straight or convex linear slope shape. Mean annual precipitation is 20 inches, as estimated from SCS precipitation maps. Mean annual temperature (30-year normal) for nearby Philipsburg is 41 °F, with July normals of 61 °F and January normals of 21 °F.

Vegetation—This is an 80-year-old lodgepole pine stand having a site index of 87. Habitat type for this stand is *Abies lasiocarpa/Linnaea borealis-Linnaea borealis* phase. The dominant seral species is *Pinus contorta.* The understory is dominated by *Vaccinium globulare, V. scoparium, Arnica latifolia, A. cordifolia,* and *Chimaphila umbellata. Goodyera oblongifolia, Linnaea borealis,* and *Xerophyllum tenax* are common. *Spiraea betulifolia, Lonicera utahensis,* and *Arctostaphylos uva-ursi* are present infrequently. Pinegrass is expected but not found in our samples.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on seven 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	38.6	243	253
4	46.7	200	438
5	52.9	200	766
6	58.0	314	1,875
7	62.3	214	1,847

SUMMARIES (TABLES 11-13)

Table 11—Gross product estimates per acre for the Ballard Hill South sample unit, using the stand table as a basis for prediction

D.b.h.	Products[1]							Residual	
class	1	2	3	4	5	6	7	volume	Value
Inches	*Number*							*Ft³*	
3						243		60.75	$121.50
4			200		200			30.00	348.00
5	400			200				0.00	498.00
6	942		314					0.00	879.20
7	214		214				214	21.40	885.96
Total									$2,732.66

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 12—Summary of defect occurrence for the Ballard Hill South sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				
	0	1	2+	1	2	3	4	Sweep
Inches	*Percentage of stems*							
3	24	35	41	53	35	6	24	0
4	7	50	43	86	14	14	14	14
5	0	43	57	50	57	43	21	0
6	23	50	27	50	18	23	9	0
7	46	47	7	40	13	0	7	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 13—Gross and net product estimates per acre for the Ballard Hill South sample unit, using individual tree records as a basis for prediction

D.b.h. class		Products[1]							Residual volume	Value
		1	2	3	4	5	6	7		
Inches		*Number*							*Ft³*	
3	Gross					100	143		19.87	$121.50
	Net					43	57		89.56	50.00
4	Gross		86	86		215			25.51	270.04
	Net		14	14		114	71		124.77	118.96
5	Gross	314		57	143				0.56	441.31
	Net	129	43	57	14				337.77	186.01
6	Gross	814		257	57				4.99	824.61
	Net	614	29	157	100				310.17	677.81
7	Gross	271		129				200	26.23	776.88
	Net	415		114				129	121.05	664.18
Total										
	Gross									$2,434.34
	Net									$1,696.96

Reduction in total value due to defect = 30.3 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Dry Fork East

STAND DESCRIPTION

Location—This unit is located on the Kings Hill Ranger District of the Lewis and Clark National Forest, in T. 15 N., R. 8 E., sec. 6, Montana Principal Meridian. It is approximately 14 miles east of Monarch, MT, via Dry Fork Belt Creek Road (No. 120).

Physical Features and Climate—This stand is located on 15- to 30-percent slopes on a north-facing aspect at an elevation of 5,400 feet. Local relief is characterized by straight slopes and benches between deep draws. Mean annual precipitation is 20 inches, based on SCS maps. Annual precipitation for Neihart is 20 to 25 inches.

Vegetation—Dry Fork East is a 57-year-old lodgepole pine stand having a site index of 77. Habitat type for this stand is *Pseudotsuga menziesii/Linnaea borealis-Calamagrostis rubescens* phase. The dominant seral species is *Pinus contorta*. The understory is dominated by *Calamagrostis rubescens, Aster conspicuus, Spiraea betulifolia*, and *Rosa acicularis*. *Symphoricarpos albus, Berberis repens*, and *Linnaea borealis* are common. *Galium boreale, Pyrola secunda*, and *Clematis columbiana* occur. The tall shrub *Acer glabrum* is present.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on nine 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	31.7	666	566
4	36.3	378	635
5	39.8	100	284
6	42.7	11	48
7	45.1	0	0

SUMMARIES (TABLES 14-16)

Table 14—Gross product estimates per acre for the Dry Fork East sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	*Number*							*Ft³*	
3						666		19.98	$333.00
4		378			378			18.90	434.70
5	100		100					4.00	176.00
6	22		11					0.88	25.08
7								0.00	0.00
Total									$968.78

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 15—Summary of defect occurrence for the Dry Fork East sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				
	0	1	2+	1	2	3	4	Sweep
Inches	*Percentage of stems*							
3	25	48	27	27	23	25	23	5
4	21	59	20	21	24	29	32	0
5	56	22	22	0	11	11	33	0
6	0	100	0	100	0	0	0	0
7	0	0	0	0	0	0	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 16—Gross and net product estimates per acre for the Dry Fork East sample unit, using individual tree records as a basis for prediction

D.b.h. class	Products[1]							Residual volume	Value
	1	2	3	4	5	6	7		
Inches	*Number*							*Ft^3*	
3 Gross					322	344		49.04	$333.00
Net					211	122		197.95	166.50
4 Gross		167	33		377			81.07	337.97
Net		44			245	67		191.43	184.60
5 Gross	56		45	55				1.36	164.67
Net	33		44	44				29.39	135.52
6 Gross	11		11					1.87	19.36
Net				11				3.22	15.95
7 Gross								0	0
Net								0	0
Total									
Gross									$855.00
Net									$502.57

Reduction in total value due to defect = 41.2 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Corduroy Creek East

STAND DESCRIPTION

Location—This unit is located on the Philipsburg Ranger District of the Deerlodge National Forest, in T. 9 N., R. 15 W., sec. 28, Montana Principal Meridian. The unit is approximately 26 miles northwest of Philipsburg, MT, via State Route 348 and Upper Willow Creek Road (No. 88).

Physical Features and Climate—This stand is located on gentle slopes (5 to 10 percent) with a southwest-facing aspect at an elevation of 5,900 feet. Local relief is characterized by convex slopes and benches. Mean annual precipitation is about 20 inches, based on SCS maps. Mean annual temperature of 40 °F at Philipsburg is probably representative. Local frost pockets are commonly encountered.

Vegetation—Corduroy Creek East is an 85-year-old lodgepole pine stand with a site index of 78. Habitat type for this stand is *Abies lasiocarpa/Vaccinium caespitosum*. *Pinus contorta* is the dominant seral species and is often found reproducing. The understory is dominated by *Vaccinium caespitosum, V. scoparium, Calamagrostis rubescens, Linnaea borealis*, and *Arctostaphylos uva-ursi* forming a dense ground cover. *Vaccinium globulare, Spiraea betulifolia*, and *Xerophyllum tenax* are present infrequently.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on six 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	40.1	700	756
4	46.1	617	1,339
5	50.7	317	1,160
6	54.5	233	1,300
7	57.7	33	262

SUMMARIES (TABLES 17-19)

Table 17—Gross product estimates per acre for the Corduroy Creek East sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	*Number*							*Ft³*	
3						700		175.00	$350.00
4			617		617			92.55	1,073.58
5	634		317					0.00	722.76
6	699		233					0.00	652.40
7	33		33				33	3.30	136.62
Total									$2,935.36

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 18—Summary of defect occurrence for the Corduroy Creek East sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	*Percentage of stems*							
3	18	27	55	60	29	20	29	0
4	24	27	49	43	22	22	41	0
5	32	42	26	53	21	11	16	0
6	14	57	29	36	43	7	21	0
7	100	0	0	0	0	0	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 19—Gross and net product estimates per acre for the Corduroy Creek East sample unit, using individual tree records as a basis for prediction

D.b.h. class	Products[1]							Residual volume	Value
	1	2	3	4	5	6	7		
Inches	*Number*							*Ft³*	
3 Gross					217	567		84.68	$392.00
Net					167	250		285.79	208.50
4 Gross		67	517		718			55.16	1,043.63
Net		100	184		518	83		333.85	593.66
5 Gross	617		200	117				0.68	738.49
Net	433		234	66				178.29	611.02
6 Gross	650		200	33				1.69	633.85
Net	500		183	50				221.17	559.42
7 Gross	67		17				33	3.30	134.46
Net	67		17				33	3.30	134.46
Total									
Gross									$2,942.43
Net									$2,107.06

Reduction in total value due to defect = 28.4 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Corduroy Creek West

STAND DESCRIPTION

Location—This unit is located on the Philipsburg Ranger District of the Deerlodge National Forest, in T. 9 N., R. 15 W., sec. 28, Montana Principal Meridian. The unit is approximately 26 miles northwest of Philipsburg, MT, via State Route 348 and Upper Willow Creek Road (No. 88).

Physical Features and Climate—This stand is located on gentle slopes (5 to 10 percent) with a southwest-facing aspect at an elevation of 5,900 feet. Local relief is characterized by convex slopes and benches. Mean annual precipitation is about 20 inches, based on SCS maps. Mean annual temperature of 40 °F at Philipsburg is probably representative. Local frost pockets are commonly encountered.

Vegetation—Corduroy Creek West is an 88-year-old lodgepole pine stand with a site index of 69. Habitat type for this stand is *Abies lasiocarpa/Vaccinium caespitosum*. *Pinus contorta* is the dominant seral species and is often found reproducing. The understory is dominated by *Vaccinium caespitosum, V. scoparium, Calamagrostis rubescens, Linnaea borealis*, and *Arctostaphylos uva-ursi* forming a dense ground cover. *Vaccinium globulare, Spiraea betulifolia*, and *Xerophyllum tenax* are present infrequently.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on six 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	Ft^3
3	37.2	916	916
4	42.7	533	1,066
5	47.0	200	676
6	50.5	150	773
7	53.4	17	125

SUMMARIES (TABLES 20-22)

Table 20—Gross product estimates per acre for the Corduroy Creek West sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	*Number*							Ft^3	
3						916		119.08	$458.00
4			533		533			79.95	927.42
5	200			200				0.00	394.00
6	300			150				1.50	373.50
7	51						17	1.70	66.98
Total									$2,219.90

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 21—Summary of defect occurrence for the Corduroy Creek West sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	*Percentage of stems*							
3	7	39	54	63	31	31	32	0
4	25	28	47	53	28	16	16	0
5	50	17	33	42	8	8	17	0
6	33	33	34	56	33	11	0	0
7	100	0	0	0	0	0	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 22—Gross and net product estimates per acre for the Corduroy Creek West sample unit, using individual tree records as a basis for prediction

D.b.h. class		Products[1]							Residual volume	Value
		1	2	3	4	5	6	7		
Inches		*Number*							*Ft³*	
3	Gross					300	717		127.78	$508.50
	Net					267	233		395.59	250.00
4	Gross		50	450		599			62.89	890.00
	Net		50	150		383	217		264.83	518.50
5	Gross	350		83	117				0.00	454.57
	Net	267		66	117				89.83	390.33
6	Gross	317		50	100				3.64	371.84
	Net	267	17	17	117				76.17	340.62
7	Gross	17		17				17	1.70	70.38
	Net	17		17				17	1.70	70.38
Total										
	Gross									$2,295.29
	Net									$1,569.83

Reduction in total value due to defect = 31.6 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Echo Lake

STAND DESCRIPTIONS

Location—This unit is on the Philipsburg Ranger District of the Deerlodge National Forest, in T. 6 N., R. 13 W., sec. 31, Montana Principal Meridian. The unit is approximately 2 miles north of Georgetown Lake via Echo Lake Road.

Physical Features and Climate—This stand is located on a 20 percent slope with northwest-facing aspect at an elevation of 6,700 feet. Local relief is characterized by straight linear slopes. Mean annual precipitation is 18 inches, represented by the 30-year normal from nearby Silver Lake. Mean annual temperature is likely slightly lower than the 40 °F for Philipsburg.

Vegetation—This is an 88-year-old lodgepole pine stand having a site index of 70. Habitat type for this stand is *Pseudotsuga menziesii/Linnaea borealis-Calamagrostis rubescens* phase. The dominant seral species is *Pinus contorta*. The understory is dominated by *Arnica latifolia, Calamagrostis rubescens, Vaccinium myrtillus*, and *Linnaea borealis. Vaccinium globulare, Spiraea betulifolia, Menziesia ferruginea*, and *Alnus sinuata* are present infrequently.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on six 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	36.3	1,667	1,634
4	41.5	600	1,164
5	45.6	100	327
6	48.8	83	413
7	51.6	0	0

SUMMARIES (TABLES 23-25)

Table 23—Gross product estimates per acre for the Echo Lake sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	*Number*							*Ft³*	
3						1,667		216.71	$833.50
4			600		600			18.00	1,044.00
5	100			100				0.00	197.00
6	166			83				0.83	206.67
7								0.00	0.00
Total									$2,281.17

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 24—Summary of defect occurrence for the Echo Lake sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	*Percentage of stems*							
3	46	42	12	38	9	5	8	0
4	56	28	16	25	8	17	11	0
5	83	0	17	17	0	0	17	0
6	80	0	20	20	20	0	0	0
7	0	0	0	0	0	0	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 25—Gross and net product estimates per acre for the Echo Lake sample unit, using individual tree records as a basis for prediction

D.b.h. class	Products[1]							Residual volume	Value
	1	2	3	4	5	6	7		
Inches	*Number*							*Ft³*	
3 Gross					350	1,350		168.31	$850.00
Net					300	1,084		337.32	692.00
4 Gross		167	417		618			37.96	934.63
Net		83	250		616	100		138.49	721.95
5 Gross	133		33	67				0.00	207.23
Net	117		34	67				10.17	200.15
6 Gross	233		83					1.36	224.08
Net	200		84					42.53	208.16
7 Gross								0	0
Net								0	0
Total									
Gross									$2,215.94
Net									$1,822.26

Reduction in total value due to defect = 17.8 percent

[1]Products:
1 = 7-foot post
2 = 13-foot rail
3 = 17-foot rail
4 = 21-foot rail
5 = 10-foot prop
6 = 17-foot panel pole
7 = 17-foot barn pole

Getcho

STAND DESCRIPTION

Location—This unit is located on the Hebgen Lake Ranger District of the Gallatin National Forest, in T. 14 S., R. 5 E., sec. 9, Montana Principal Meridian. The unit is approximately 3 miles southwest of West Yellowstone, MT, via a spur road off Madison Plateau Road 1700.

Physical Features and Climate—This stand is located on gentle (0 to 10 percent) slopes with a southwest-facing aspect at an elevation of 6,800 feet. Local relief is characterized by gently rolling terrain. Mean annual precipitation is 25 to 30 inches. Long-term (30-year normal) mean for West Yellowstone is 22 inches, with 60 percent of this coming as snow. Normal mean annual temperature for West Yellowstone is 35 °F, with July normals of 60 °F and January normals of 12 °F. Frost-free season is short (50 to 90 days).

Vegetation—This is a 100-year-old lodgepole pine stand having a site index of 62. Habitat type for this stand is *Abies lasiocarpa / Calamagrostis rubescens*. The dominant seral species is *Pinus contorta*. The understory is dominated by *Calamagrostis rubescens* and *Vaccinium scoparium*. *Arnica latifolia*, *Lupinus* sp., and *Vicia americana* occur frequently. No tall shrubs were found.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on eight 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	35.3	375	356
4	41.0	463	884
5	45.4	313	1,020
6	49.0	150	749
7	52.0	50	357

SUMMARIES (TABLES 26-28)

Table 26—Gross product estimates per acre for the Getcho sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	*Number*							*Ft³*	
3						375		48.75	$187.50
4			463		463			13.89	805.62
5	313			313				0.00	616.61
6	300			150				1.50	373.50
7			50				50	9.00	181.00
Total									$2,164.23

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 27—Summary of defect occurrence for the Getcho sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	*Percentage of stems*							
3	3	38	59	84	19	22	25	6
4	3	24	73	92	24	35	24	5
5	4	28	68	80	24	40	12	4
6	0	33	67	83	33	8	25	0
7	0	0	100	100	50	75	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 28—Gross and net product estimates per acre for the Getcho sample unit, using individual tree records as a basis for prediction

D.b.h. class		Products[1]							Residual volume	Value
		1	2	3	4	5	6	7		
Inches		*Number*							*Ft^3*	
3	Gross					100	275		34.75	$187.50
	Net					88	101		139.56	94.50
4	Gross		125	263		463			46.39	638.87
	Net		25	13		351	50		337.91	232.87
5	Gross	375		112	200				1.48	623.88
	Net	200	63	101	75				287.95	378.94
6	Gross	313		87	63				4.38	361.99
	Net	238		113	25				131.50	300.13
7	Gross	75		25				50	5.31	189.00
	Net	88	13	13					148.63	70.33
Total										
	Gross									$2,001.24
	Net									$1,076.77

Reduction in total value due to defect = 46.2 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Cottonwood Ridge East

STAND DESCRIPTION

Location—This unit is located on the Mountain View Ranger District of the Wasatch National Forest in T. 3 N., R. 14 E., sec. 21, Salt Lake Principal Meridian. The unit is approximately 26 miles south of Mountain View, WY, via Bridger Lake Road (No. 072), Road No. 017, and Road No. 087.

Physical Features and Climate—This stand is located on 3- to 5-percent slopes with northeast- to east-facing aspects at an elevation of 9,600 feet. Local relief is characterized by gently sloping benches dissected with very shallow and flat drainages. Mean annual precipitation is 26 inches. Mean annual temperature is 28 °F, with a July mean of 50 °F and a January mean of 13 °F.

Vegetation—This is a 120-year-old lodgepole pine stand with a site index of 52. Habitat type for this stand is *Pinus contorta/Vaccinium scoparium. Pinus contorta* is the dominant seral species and is often found reproducing. The understory is dominated by *Vaccinium scoparium. Arnica cordifolia, Poa nervosa, Antennaria* spp., *Fragaria virginiana, Arnica rossii,* and *Aster* spp. are commonly encountered. *Epilobium angustifolium, Achillea millefolium,* and *Hieracium albiflorum* are also present. Litter covers 76 to 86 percent of the ground.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on seven 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft^3*
3	27.7	871	636
4	32.3	771	1,149
5	35.8	300	762
6	38.7	29	113
7	41.1	14	78

SUMMARIES (TABLES 29-31)

Table 29—Gross product estimates per acre for the Cottonwood Ridge East sample unit, using the stand table as a basis for prediction

D.b.h.	Products[1]							Residual	
class	1	2	3	4	5	6	7	volume	Value
Inches				*Number*				*Ft^3*	
3						871		26.13	$435.50
4					771			346.95	385.50
5				300				0.00	435.00
6	29			29				0.00	57.13
7	56							1.40	29.12
Total									$1,342.25

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 30—Summary of defect occurrence for the Cottonwood Ridge East sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	*Percentage of stems*							
3	20	31	49	47	23	24	44	5
4	18	42	40	47	22	35	42	0
5	29	33	38	38	19	29	19	5
6	33	34	33	0	33	0	33	0
7	0	0	100	100	0	0	100	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 31—Gross and net product estimates per acre for the Cottonwood Ridge East sample unit, using individual tree records as a basis for prediction

D.b.h. class		Products[1]							Residual volume	Value
		1	2	3	4	5	6	7		
Inches		*Number*							*Ft*[3]	
3	Gross					471	400		68.11	$435.50
	Net					186	157		295.99	171.50
4	Gross		214	14		771			221.99	541.96
	Net		57			486	71		419.35	315.55
5	Gross	114		100	200				2.84	473.28
	Net	100	57	43	100				204.96	287.37
6	Gross	29		14	14				2.38	52.74
	Net	28		28					10.14	49.28
7	Gross	57							1.43	29.64
	Net	43							19.29	22.36
Total										
	Gross									$1,533.12
	Net									$846.06

Reduction in total value due to defect = 44.8 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Cottonwood Mountain

STAND DESCRIPTION

Location—This unit is located on the Mountain View Ranger District of the Wasatch National Forest, in T. 12 N., R. 115 W., sec. 22, sixth principal meridian. The unit is approximately 20 miles south of Mountain View, WY, via Bridger Lake Road (No. 072) and Road No. 017.

Physical Features and Climate—This stand is located on flat ground with northwest- to east-facing aspects at an elevation of 9,400 feet. Local relief is characterized by gently sloping benches dissected with very shallow and flat drainages. Mean annual precipitation is 24.5 inches. Mean annual temperature is 28 °F, with a July mean of 50 °F and a January mean of 13 °F.

Vegetation—Cottonwood Mountain is a 122-year-old lodgepole pine stand, with a site index of 55. Habitat type is *Pinus contorta/Carex rossii*. *Pinus contorta* is the sole tree species. No shrubs were found although *Juniperus communis* or *Rosa* spp. are known to occur. Herbaceous growth is dominated by *Arnica cordifolia, Poa nervosa, Aster* spp., and *Achillea millefolium. Epilobium angustifolium, Penstemon confertus, Calamagrostis rubescens,* and *Trifolium repens* are also present. Litter covers 83 percent of the surface.

Stand Inventory—Based on all stems of 3-inch d.b.h. and larger on six 1/100-acre plots:

D.b.h. class	Average height	Stems per acre	Volume per acre
Inches	*Feet*	*Number*	*Ft³*
3	28.6	383	291
4	33.9	400	628
5	38.1	417	1,130
6	41.4	200	838
7	44.3	84	507

SUMMARIES (TABLES 32-34)

Table 32—Gross product estimates per acre for the Cottonwood Mountain sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	Number							Ft^3	
3						383		11.49	$191.50
4		400			400			20.00	460.00
5	417		417					16.68	733.92
6	200			200				0.00	394.00
7	168						84	4.20	287.28
Total									$2,066.70

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

Table 33—Summary of defect occurrence for the Cottonwood Mountain sample stand

D.b.h. class	Number of defects			Presence of locatable[1] defects by quarter[2]				
	0	1	2+	1	2	3	4	Sweep
Inches	*Percentage of stems*							
3	11	39	50	39	32	32	50	11
4	15	39	46	54	19	31	42	0
5	46	35	19	15	4	15	31	4
6	23	23	54	23	54	54	23	0
7	29	14	57	29	29	29	43	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot cluster, and swell.
[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 to 25 percent).

Table 34—Gross and net product estimates per acre for the Cottonwood Mountain sample unit, using individual tree records as a basis for prediction

D.b.h. class	Products[1]							Residual volume	Value
	1	2	3	4	5	6	7		
Inches	*Number*							*Ft³*	
3 Gross					167	217		28.15	$192.00
Net					116	17		154.06	66.50
4 Gross		117	33		400			107.28	316.97
Net		67			250	50		185.96	193.55
5 Gross	67		233	183				2.68	589.11
Net	84	50	150	117				152.06	431.83
6 Gross	233		183	17				28.14	372.73
Net	150	67	50					259.79	183.55
7 Gross	233		17				33	8.91	220.78
Net	200		17					125.00	125.08
Total									
Gross									$1,691.59
Net									$1,000.51

Reduction in total value due to defect = 40.9 percent

[1]Products: 1 = 7-foot post; 2 = 13-foot rail; 3 = 17-foot rail; 4 = 21-foot rail; 5 = 10-foot prop; 6 = 17-foot panel pole; 7 = 17-foot barn pole

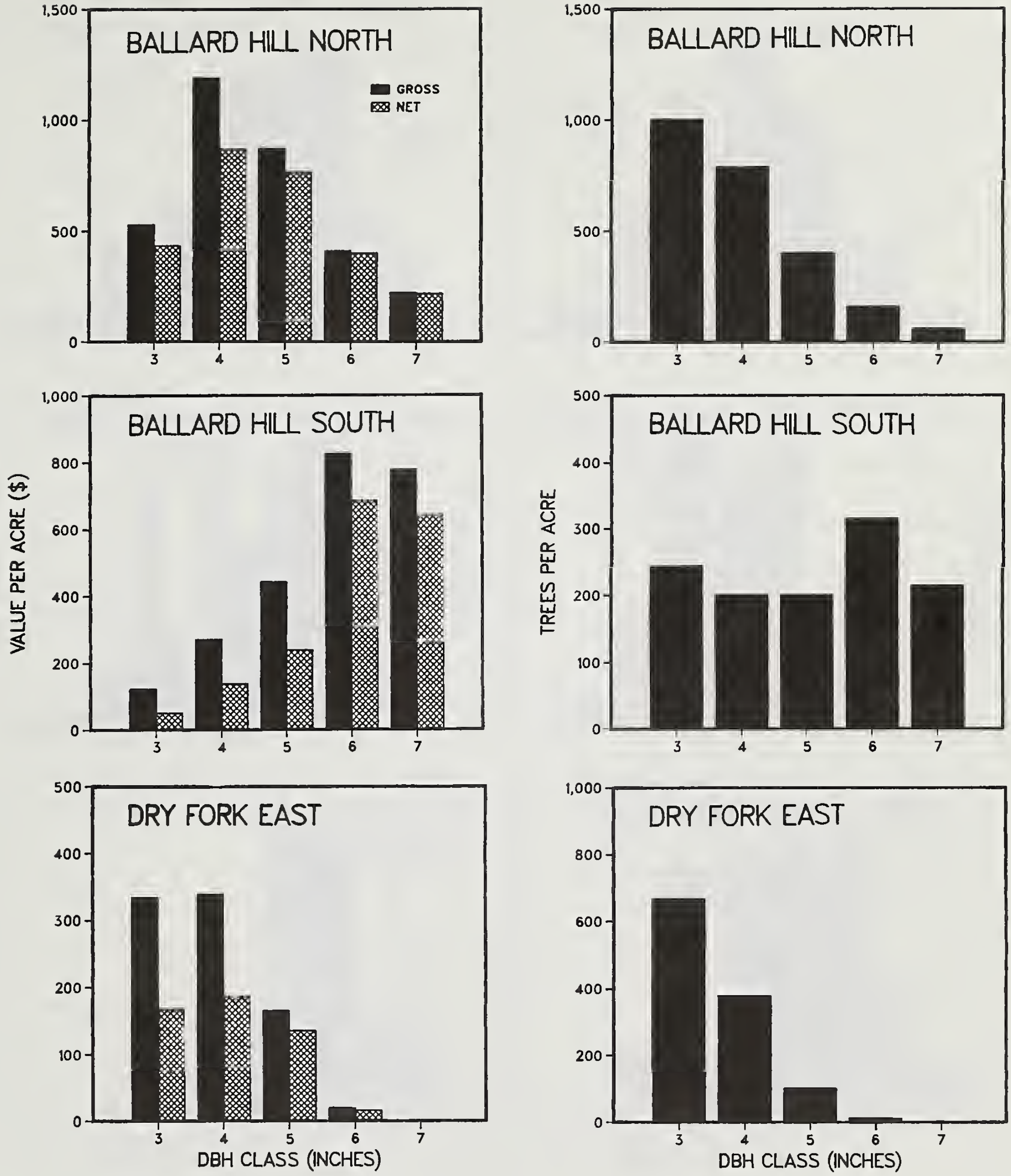


Figure 1—Trees per acre, gross and net values estimated from individual tree data for three of the nine sample stands: Ballard Hill North, Ballard Hill South, and Dry Fork East.

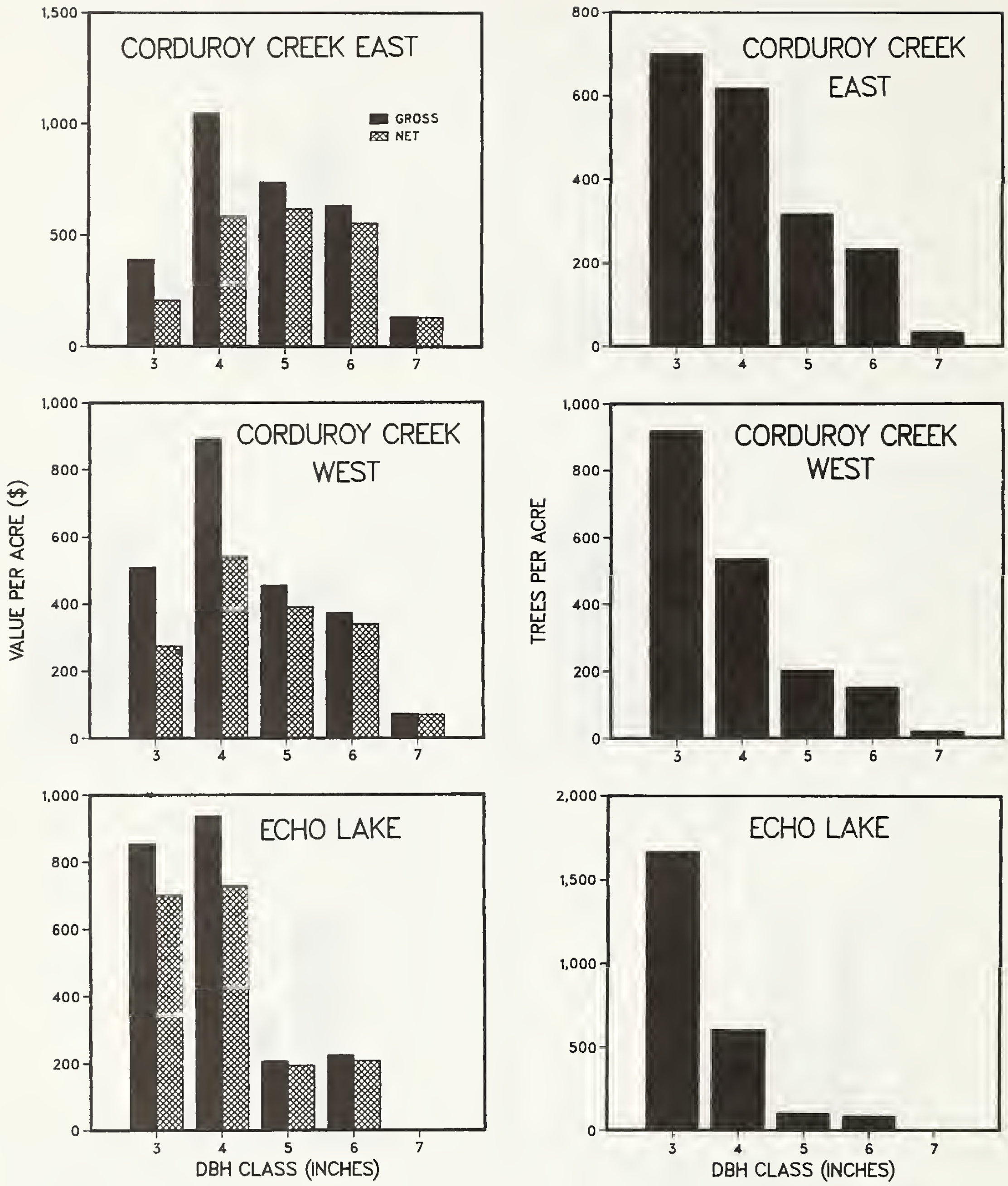


Figure 2—Trees per acre, gross and net values estimated from individual tree data for three of the nine sample stands: Corduroy Creek East, Corduroy Creek West, and Echo Lake.

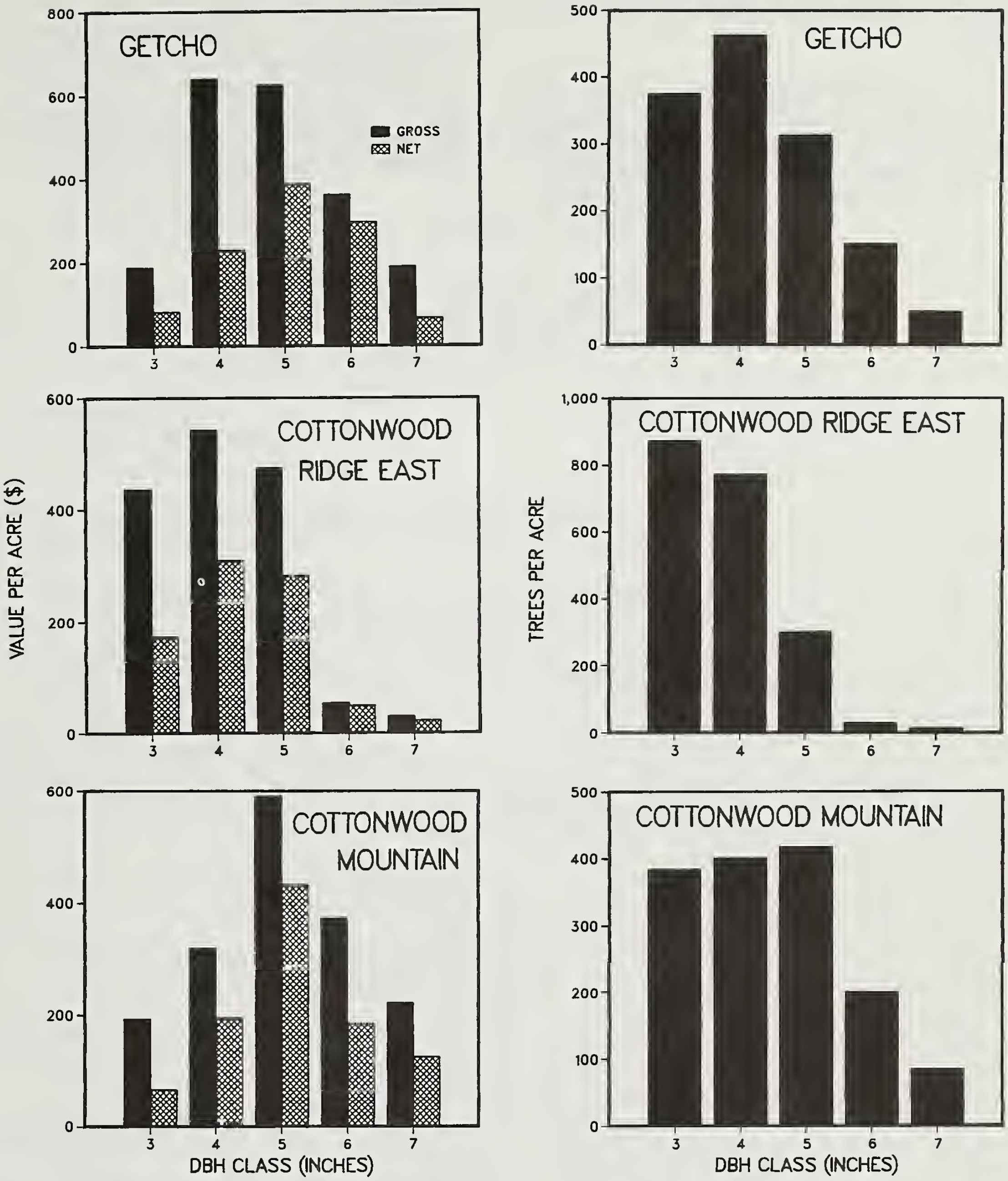


Figure 3—Trees per acre, gross and net values estimated from individual tree data for three of the nine sample stands: Getcho, Cottonwood Ridge East, and Cottonwood Mountain.

APPENDIX D: COMPUTER PROGRAM LISTINGS

This appendix provides program listings for three computer routines necessary in predicting product potential. The programs are written in standard FORTRAN 77. A user might need to make some modifications to run the programs on a local computer, but these should be minor.

The first program produces tables of gross product alternatives by d.b.h. class. The user can define a maximum of seven products. Gross product estimates based on stand table information and chosen product alternatives can be obtained from the second program. If tree defects have been measured for a stand, the third program will give net product estimates.

Program 1—Computer Listing for Obtaining Gross Product Alternatives With User-Defined Products

```
C     PROGRAM 1

C     **********************************************************
C     GROSS PRODUCT ALTERNATIVES WITH USER-DEFINED PRODUCTS
C         PROGRAMMER : N. HERRIN
C          REVISIONS : J. SCHLIETER
C     **********************************************************

C     PROGRAM TO OBTAIN PRODUCT ALTERNATIVES FOR EACH DEFINED
C     HEIGHT CLASS IN DBH CLASSES 3 TO 7 -- USER CAN SPECIFY
C     AT MOST 7 PRODUCTS AND WILL TYPE IN NAME, LENGTH, SMALL
C     DIAM SPECS, LARGE DIAM SPECS, PRODUCT VALUE

C     UNIT ASSIGNMENTS ARE :
C          UNIT  6 = USER CONSOLE
C          UNIT 22 = OUTPUT FILE

      CHARACTER PROD(7)*10,BUTT*3,PRODUCT*3,PRO*3,DASH(7)*12,
     1RS*12,DASH2*12,VL*12,PIECE*3

      REAL SPEC(7,6),MIND(5),MAXD(5),MLEN(5,8),MINLEN(5),MAXLEN(5),
     1LDBH(10),SDBH(10),LEN(10),RESID(20),VAL,TAP(5,8)

      INTEGER NUMPROD,ICT,IPROD,LASTPROD(20),NUM(7),NPROD(7),
     1OLDALT(50,7)

C MERCHANTABLE LENGTH ARRAY -- FROM TABLE 1
      DATA((MLEN(I,J),J=1,8),I=1,5)/15.,19.,23.,27.,31.,36.,0.,0.,18.,
     *22.,26.,30.,34.,38.,42.,0.,0.,18.,22.,26.,29.,33.,37.,0.,0.,0.,
     *27.,30.,34.,38.,41.,0.,0.,0.,0.,29.,32.,36.,39.,42./

C MINIMUM DIAM ARRAY (CORRESPONDS TO DBH CLASS)
      DATA(MIND(J),J=1,5)/2.00,2.00,3.00,3.00,4.00/

C MAXIMUM DIAM ARRAY (CORRESPONDS TO DBH CLASS)
      DATA(MAXD(J),J=1,5)/3.00,4.00,5.00,6.00,7.00/

C MINIMUM TREE HEIGHT CLASS FOR EACH DBH
      DATA(MINLEN(J),J=1,5)/25.,25.,30.,35.,40./

C MAXIMUM TREE HEIGHT CLASS FOR EACH DBH
      DATA(MAXLEN(J),J=1,5)/50.,3*55.,60./

C STEM TAPER -- DEPENDS ON DBH AND HEIGHT CLASS
      DATA((TAP(I,J),J=1,8),I=1,5)/.0714,.0556,.0455,.0385,.0333,.0286,
     *0.,0.,.1144,.0893,.0713,.0595,.0511,.0455,.0405,0.,0.,.1144,.0893,
     *.0733,.0635,.0530,.0478,0.,0.,0.,.1077,.0902,.0788,.0683,.0625,0.,
     *0.,0.,0.,.1012,.0901,.0813,.0740,.0688/

      COMMON SPEC,LDBH,SDBH,LEN,NPROD,IPROD,ICT,RESID,AST,LASTPROD,
     1NUMPROD,LASTCT,NUM
      COMMON /BK1/PRODUCT,PIECE
      OPEN(6,FILE='@CONSOLE')
      OPEN(22, FILE='PRODALT.OUT',CARRIAGECONTROL='FORTRAN')

*******  INPUT PRODUCTS OR END PROGRAM  *******

    1 WRITE(6,2)
    2 FORMAT(///' Do you want to :(1)Input products  or (2)Quit ?')
      PRINT 500
  500 FORMAT('     ENTER 1 OR 2 : ',$)
```

```
      READ *,IN
      IF(IN.EQ.2) GO TO 1000
      IF(IN.NE.1.) THEN
        WRITE(6,3)
    3   FORMAT(/'  You MUST enter a 1 or 2!  Try Again!'/)
        GO TO 1
      ENDIF

*******  QUERY FOR PRODUCTS AND THEIR SPECIFICATIONS  *******

      NUMPROD=0
      WRITE(6,4)
    4 FORMAT(///'  You can input up to 7 products and their specificatio
     1ns.'/'  The specifications are:'/'    -NAME'/'    -LENGTH'/'    -S
     2MALL diameter constraints -  min  and  max  constraint'/'    -LARG
     3E diameter constraints -  min  and  max  constraint'/'    -VALUE o
     4f product'//)
   10 NUMPROD=NUMPROD + 1
      IF(NUMPROD.GT.7) THEN
         NUMPROD=7
         GO TO 19
      ENDIF
      WRITE(6,11) NUMPROD
   11 FORMAT(//'   Enter Specifications for Product #',I1/)
      PRINT 505
  505 FORMAT('     ENTER PRODUCT NAME(10 CHAR OR LESS) : ',$)
      READ(*,12) PROD(NUMPROD)
   12 FORMAT(A10)
      IF(PROD(NUMPROD).EQ.'     ') THEN
        IF(NUMPROD.EQ.1) GO TO 1
        NUMPROD=NUMPROD - 1
        GO TO 19
      ENDIF
      PRINT 510
  510 FORMAT(5X,'ENTER PRODUCT LENGTH : ',$)
      READ *,SPEC(NUMPROD,1)
      WRITE(6,13)
   13 FORMAT('     Enter SMALL Diameter Specifications:')
      PRINT 515
  515 FORMAT(8X,'MIN,MAX : ',$)
      READ *, SPEC(NUMPROD,2),SPEC(NUMPROD,3)
      WRITE(6,14)
   14 FORMAT('     Enter LARGE Diameter Specifications:')
      PRINT 515
      READ *,SPEC(NUMPROD,4),SPEC(NUMPROD,5)

******* ROUND-OFFS FOR OUR PRODUCTS MAY NOT BE NEEDED BY OTHERS
      SPEC(NUMPROD,1)=SPEC(NUMPROD,1) - .04
      SPEC(NUMPROD,2)=SPEC(NUMPROD,2) - .04
      SPEC(NUMPROD,4)=SPEC(NUMPROD,4) - .04
      SPEC(NUMPROD,3)=SPEC(NUMPROD,3) + .05
      SPEC(NUMPROD,5)=SPEC(NUMPROD,5) + .05

      PRINT 525
  525 FORMAT('     ENTER PRODUCT VALUE : ',$)
      READ *,SPEC(NUMPROD,6)
      GO TO 10

C  INITIALIZE ARRAY COUNTERS : ICL=DBH CLASS, IFT=LENGTH, ICT=UNUSED
C    ARRAY COUNTER, IPROD=PRODUCT #, BUTT=BUTT END OF LOG, NALT= # OF
C    ALTERNATIVES PER HGT, NUMALT=COUNTER FOR ALTERNATIVE ARRAY OLDALT
```

```
   19 ICL=1
      IFT=1
      ICT=1
      IPROD=1
      BUTT='YES'
      NALT=0
      NUMALT=0

*******  WRITE HEADER  *******

      WRITE(22,20) MAXD(ICL)
   20 FORMAT('1    DBH CLASS ',F4.2//)
      RS=' RESIDUAL '
      VL='   VALUE  '
      DASH2='----------  '
      WRITE(22,25) (PROD(I),I=1,NUMPROD),RS,VL
   25 FORMAT(' HGT ALT  ',7(A10,2X),A10,2X,A10)
      DO 26 J=1,NUMPROD
        DASH(J)='----------  '
   26 CONTINUE
      WRITE(22,30) (DASH(I),I=1,NUMPROD),DASH2,DASH2
   30 FORMAT(' --- ---  ',7(A12),A12,A12/)

*******  PUT LOG INTO UNUSED ARRAY
*******      LDBH=LARGE END  SDBH=SMALL END  LEN=LENGTH
      LDBH(ICT)=MAXD(ICL)
      SDBH(ICT)=MIND(ICL)
   60 LEN(ICT)=MLEN(ICL,IFT)
      IF(LEN(ICT).EQ.0.) THEN
         IFT=IFT+1
         GO TO 60
      ENDIF

   75 BUTT='YES'
      PRODUCT='NO'
      PIECE='NO'
      DO 76 M=1,20
       LASTPROD(M)=0
       RESID(M)=0.0
   76 CONTINUE

C REDUCE MERCH LENGTH ONE FT ON BUTT END TO AVOID SWELL
      LEN(ICT)=LEN(ICT) - 1.0

C CALCULATE RESIDUAL VOLUME -- RESID
      VOL=(LDBH(ICT)**2) + (SDBH(ICT)**2)
      RESID(ICT)=.002727077*VOL*LEN(ICT)

      AST=TAP(ICL,IFT)
      VAL=0.0
      DO 80 J=1,NUMPROD
         NPROD(J)=0
   80 CONTINUE

C CALL SUBROUTINE SCAN TO SEE IF PRODUCT FITS
   90 PRO='NO'
   95 CALL SCAN

*******     IF PRODUCT FIT, CALL SCAN AGAIN TO SEE IF ANY PRODUCTS
*******     WILL FIT IN LEFTOVER PIECE
```

```
  110 IF(PRODUCT.EQ.'YES') THEN
        IPROD=1
        PRODUCT='NO'
        PRO='YES'
        CALL SCAN
        GO TO 110
      ELSE
        IF(PRO.EQ.'YES') THEN
          IF(IPROD.EQ.NUMPROD) GO TO 200
          IPROD=IPROD+1
          GO TO 95
        ENDIF
      ENDIF

******* NEXT PRODUCT, BUT FIRST WRITE THE ALTERNATIVE OBTAINED
  200  IF(PRO.EQ.'NO') GO TO 235
         NUMALT=NUMALT+1
         VAL=0.0
         IF(RESID(ICT).LT.0.0) RESID(ICT)=0.0
         DO 205 I=1,NUMPROD
           OLDALT(NUMALT,I)=NPROD(I)
           VAL=VAL+(FLOAT(OLDALT(NUMALT,I))*SPEC(I,6))
  205    CONTINUE
         IF(NALT.EQ.0) THEN
           NALT=NALT+1
           WRITE(22,210)MINLEN(ICL),NALT,(FLOAT(NPROD(I)),I=1,NUMPROD),
     1RESID(ICT),VAL
  210      FORMAT(/' ',F3.0,' ',I3,2X,8(F7.2,5X),F7.2)
         ELSE

C SEE IF ALTERNATIVE ALREADY EXISTS
           DO 220 J=1,NUMALT-1
             DO 215 I=1,NUMPROD
               IF(NPROD(I).EQ.OLDALT(J,I)) GO TO 215
               GO TO 220
  215        CONTINUE
             GO TO 235
  220      CONTINUE
           NALT=NALT+1
           WRITE(22,225)NALT,(FLOAT(NPROD(I)),I=1,NUMPROD),RESID(ICT),
     1VAL
  225      FORMAT('      ',I3,2X,8(F7.2,5X),F7.2)
         ENDIF
      IF(ICT.GE.2) THEN
        IF(PRO.EQ.'NO') GO TO 235
        ICT=ICT-1
        J=LASTPROD(ICT)
        NPROD(J)=NPROD(J) - 1
        IF(ICT.EQ.1) THEN
          DO 226 J=1,NUMPROD
            NPROD(J)=0
  226     CONTINUE
        ENDIF
        IF(IPROD.GE.NUMPROD) GO TO 238
  235   IF(IPROD.GE.NUMPROD) THEN
          IF(ICT.EQ.1) THEN
           DO 236 J=1,NUMPROD
            NPROD(J)=0
  236      CONTINUE
           GO TO 238
          ENDIF
```

```
          J=LASTPROD(ICT-1)
          NPROD(J)=NPROD(J) - 1
          ICT=ICT-1
          IPROD=LASTPROD(ICT)+1
          IF(IPROD.GT.NUMPROD) GO TO 240
          IF(PIECE.EQ.'YES') THEN
            IF(ICT.LT.LASTCT) THEN
              PIECE='NO'

******* TAKE AWAY ALL PRODUCTS MADE FROM SPLIT LOG
              DO 237 K=1,NUMPROD
                NPROD(K)=NPROD(K) - NUM(K)
  237         CONTINUE
            ENDIF
          ENDIF
          GO TO 239
       ENDIF
  238  IF(PRO.EQ.'NO') THEN
          IPROD=IPROD+1
          IF(IPROD.GT.NUMPROD) GO TO 240
          GO TO 239
       ENDIF
       IPROD=LASTPROD(ICT)+1
  239  GO TO 90
     ENDIF

*******  GO TO NEXT HEIGHT CLASS
  240    IPROD=1
         NALT=0
         NUMALT=0
         IFT=IFT+1
         MINLEN(ICL)=MINLEN(ICL)+5.
  250    IF(IFT.GT.8) THEN

*******  GO TO NEXT DBH CLASS
            IFT=1
            ICL=ICL+1
            IF(ICL.GT.5) GO TO 1000

*******  WRITE HEADINGS
            WRITE(22,20) MAXD(ICL)
            WRITE(22,25) (PROD(I),I=1,NUMPROD),RS,VL
            WRITE(22,30) (DASH(I),I=1,NUMPROD),DASH2,DASH2
         ENDIF

*******  PUT LOG INTO ARRAY
      ICT=1
      LDBH(ICT)=MAXD(ICL)
      SDBH(ICT)=MIND(ICL)
  270 LEN(ICT)=MLEN(ICL,IFT)
      IF(LEN(ICT).EQ.0.) THEN
        IFT=IFT+1
        IF(IFT.GT.8) GO TO 250
        GO TO 270
      ENDIF
      GO TO 75

 1000 STOP
      END
```

```
      SUBROUTINE SCAN

C          THIS SUBROUTINE SCANS FOR PRODUCTS

      CHARACTER PRODUCT*3,PRO*3,PIECE*3

      REAL SPEC(7,6),RESID(20),DIVL(2),DIVS(2),DIVLN(2),
     1LDBH(10),SDBH(10),LEN(10),L,TAP(5,8)

      INTEGER ICT,NUMPROD,IPROD,LASTPROD(20),NUM(7),NPROD(7)

      COMMON SPEC,LDBH,SDBH,LEN,NPROD,IPROD,ICT,RESID,AST,LASTPROD,
     1NUMPROD,LASTCT,NUM
      COMMON /BK1/PRODUCT,PIECE

      J=IPROD

C CHECK IF LARGE DIAMETER WITHIN PRODUCT SPECS
  370 IF((LDBH(ICT).LE.SPEC(J,5)).AND.(LDBH(ICT).GE.SPEC(J,4)))
     1THEN

C CHECK LENGTH TO SEE IF PRODUCT FITS
       IF(LEN(ICT).GE.SPEC(J,1)) THEN

C IF LENGTH EQUALS PRODUCT LENGTH, MAKE SURE SMALL DIAM IS LARGER
C THAN MINIMUM SMALL DIAM
        IF(LEN(ICT).EQ.SPEC(J,1)) THEN
          IF(SDBH(ICT).LT.SPEC(J,2)) GO TO 425
        ENDIF

C CALCULATE SMALL DIAM AT PRODUCT LENGTH
          D1=LDBH(ICT)-(SPEC(J,1)*AST)
          IF(D1.LT.SDBH(ICT))D1=SDBH(ICT)

C CHECK TO SEE IF SMALL DIAM WITHIN PRODUCT SPECS
          IF((D1.GE.SPEC(J,2)).AND.(D1.LE.SPEC(J,3))) THEN

C TAKE PRODUCT OUT OF PIECE
             LDBH(ICT+1)=D1
             SDBH(ICT+1)=SDBH(ICT)
             LEN(ICT+1)=LEN(ICT)-SPEC(J,1)
             V1=(LDBH(ICT)**2) + (D1**2)
             RESID(ICT+1)=RESID(ICT)- (.002727077*V1*SPEC(J,1))
             NPROD(J)=NPROD(J) + 1
             LASTPROD(ICT)=J
             ICT=ICT+1
             PRODUCT='YES'
             GO TO 600
           ELSE

C IF SMALL DIAM STILL TOO BIG, TAKE AWAY 1 FOOT AND TRY AGAIN
             IF(D1.GT.SPEC(J,3)) THEN
                LDBH(ICT)=LDBH(ICT)-AST
                LEN(ICT)=LEN(ICT)-1.0
                GO TO 370
             ENDIF
           ENDIF
        ENDIF
      ELSE

C CHECK TO SEE IF PIECE NEEDS TO BE DIVIDED -- IF SMALL DIAM GREATER
```

```
C THAN MAX LARGE DIAM OF PRODUCT, NO PRODUCT CAN BE MADE FROM PIECE
        IF(SDBH(ICT).GT.SPEC(J,5)) GO TO 425

C CHECK TO SEE IF LARGE DIAM GREATER THAN MIN LARGE DIAM
        IF(LDBH(ICT).GT.SPEC(J,4)) THEN

C CHECK LENGTH TO SEE IF IT FITS
          IF(LEN(ICT).GE.SPEC(J,1)) THEN

C DETERMINE LENGTH AT MAX LARGE DIAM -- SPEC(J,5)
            L=(LDBH(ICT)-SPEC(J,5))/AST
            IF((LEN(ICT)-L).LT.SPEC(J,1)) GO TO 425

C DIVIDE THE PIECE
            DIVL(1)=LDBH(ICT)
            DIVS(1)=SPEC(J,5)
            DIVLN(1)=L
            DIVL(2)=SPEC(J,5)
            DIVS(2)=SDBH(ICT)
            DIVLN(2)=LEN(ICT)-L

C CHECK AGAIN TO SEE IF PRODUCT WILL FIT
  400       IF((DIVL(2).LE.SPEC(J,5)).AND.(DIVL(2).GE.SPEC(J,4))) THEN
               IF(DIVLN(2).GE.SPEC(J,1)) THEN
                 D1=DIVL(2)-(SPEC(J,1)*AST)
                 IF((D1.GE.SPEC(J,2)).AND.(D1.LE.SPEC(J,3))) THEN
                   LDBH(ICT+1)=D1
                   SDBH(ICT+1)=SDBH(ICT)
                   LEN(ICT+1)=DIVLN(2)-SPEC(J,1)
                   V2=(DIVL(2)**2) + (D1**2)
                   RESID(ICT+1)=RESID(ICT)- (.002727077*V2*SPEC(J,1))
                   NPROD(J)=NPROD(J) + 1
                   LASTPROD(ICT)=J
                   ICT=ICT+1
                   LASTCT=ICT
                   PRODUCT='YES'
                   GO TO 450
                 ELSE

C IF LARGE DIAM TOO BIG, TAKE AWAY 1 FOOT AND TRY AGAIN
                   IF(D1.GT.SPEC(J,3)) THEN
                     DIVLN(1)=DIVLN(1)+1
                     DIVLN(2)=DIVLN(2)-1
                     DIVL(2)=DIVL(2)-AST
                     DIVS(1)=DIVL(2)
                     GO TO 400
                   ENDIF
                 ENDIF
               ENDIF
             ENDIF
          ENDIF
        ENDIF
      ENDIF
  425 PRODUCT='NO'
      GO TO 600


******* CHECK PIECE 1 FOR PRODUCT -- INITIALIZE THE NUMBER OF
******* PRODUCTS TAKEN OUT OF PIECE

  450 J=1
```

```
      DO 460 K=1,NUMPROD
        NUM(K)=0
  460 CONTINUE
  475 IF((DIVL(1).LE.SPEC(J,5)).AND.(DIVL(1).GE.SPEC(J,4))) THEN
        IF(DIVLN(1).GE.SPEC(J,1)) THEN
          D1=DIVL(1)-(SPEC(J,1)*AST)
          IF((D1.GE.SPEC(J,2)).AND.(D1.LE.SPEC(J,3))) THEN

C TAKE PRODUCT OUT AND CHECK REMAINING PIECE FOR PRODUCTS

            V3=(DIVL(1)**2) + (D1**2)
            RESID(ICT)=RESID(ICT)- (.002727077*V3*SPEC(J,1))
            PIECE='YES'
            DIVL(1)=D1
            DIVLN(1)=DIVLN(1)-SPEC(J,1)
            NPROD(J)=NPROD(J) + 1
            NUM(J)=NUM(J)+1
            GO TO 475
          ENDIF
        ENDIF
      ENDIF
      J=J+1
      IF(J.GT.NUMPROD) GO TO 600
      GO TO 475


  600 RETURN
      END
```

Program 2—Computer Listing for Obtaining Gross Product Estimates From Stand Table Data

```
C     PROGRAM 2
C
C    ***********************************************
C      GROSS PRODUCT POTENTIAL FROM A STAND TABLE
C          PROGRAMMER : J.SCHLIETER
C    ***********************************************
C
C     PROGRAM TO OBTAIN GROSS PRODUCT ESTIMATES FROM STAND
C     TABLE DATA -- THE USER NEEDS :
C                       1. STAND TABLE WITH AVERAGE TOTAL TREE
C                          HEIGHT AND STEMS/ACRE FOR EACH DBH
C                          CLASS
C
C                       2. GROSS PRODUCT ALTERNATIVE TABLES AS
C                          IN APPENDIX A -- USING AVERAGE TOTAL
C                          TREE HEIGHT, SELECT AN ALTERNATIVE FOR
C                          EACH DBH CLASS
C
C                       3. VALUES OF THE PRODUCTS (MAX OF 7)
C
C
C     NOTE:A WORKSHEET TO ASSIST THE USER IS GIVEN AT THE END
C          OF THE PROGRAM LISTING
C
C          UNIT ASSIGNMENTS ARE :
C             UNIT  6 = USER CONSOLE
C             UNIT 22 = OUTPUT FILE
C
C              *****************************
C                 DEFINITIONS OF VARIABLES
C              *****************************
C
C          COST(J)    = USER-ASSIGNED VALUE FOR PRODUCT J
C          NAME1,2,3  = STAND NAME (8 CHARACTERS IN EACH)
C          VGT        = TOTAL VALUE FOR STAND
C          TOTRV      = TOTAL RESIDUAL VOLUME FOR STAND
C          NTOT(J)    = TOTAL NO. OF PRODUCT J IN STAND
C          VTOT(J)    = TOTAL VALUE FOR PRODUCT J IN STAND
C          NP(I,J)    = NUMBER OF PRODUCT J IN DBH CLASS I
C          VOL(I)     = RESIDUAL VOLUME IN DBH I FOR ALTERNATIVE
C          NS(I)      = STEMS/ACRE FOR DBH CLASS I FROM STAND TABLE
C          N(I,J)     = NO./ACRE OF PRODUCT J IN DBH CLASS I
C          V(I,J)     = VALUE/ACRE OF PRODUCT J IN DBH CLASS I
C          RV(I)      = RESIDUAL VOLUME IN DBH CLASS I
C              *****************************
C
      DIMENSION COST(7),V(5,7),RV(5),VTOT(7),N(5,7),NTOT(7)
      DOUBLE PRECISION NAME1(8),NAME2(8),NAME3(8)
      COMMON NP(5,7),VOL(5),NS(5)
      OPEN(6,FILE='@CONSOLE')
      OPEN(22, FILE='GROSS.OUT',CARRIAGECONTROL='FORTRAN')
C
C     ENTER PRODUCT VALUES AT RUN TIME--THESE REMAIN FIXED
C     FOR THE ENTIRE RUN
C
      WRITE(6,30)
   30 FORMAT(2X,'TYPE 7 PRODUCT VALUES SEPARATED BY COMMAS')
      PRINT 35
   35 FORMAT('          VALUES : ',$)
      READ *, (COST(J),J=1,7)
```

```
C
C     INITIALIZE -- PROGRAM BEGINS HERE FOR EACH STAND --
C
   10 VGT=0.0
      TOTRV=0.0
      DO 20 J=1,7
          NTOT(J)=0
   20     VTOT(J)=0.0
C
C     INPUT INFORMATION FOR A PARTICULAR STAND
C
      WRITE(6,50)
   50 FORMAT(/2X,'STAND NAME--MAX OF 24 CHARACTERS : ',$)
      READ(*,60)NAME1,NAME2,NAME3
   60 FORMAT(3(8A1))
C
      I=1
   70 CALL INFO(I,NP(I,J),VOL(I),NS(I))
      IF(I.EQ.5)GO TO 75
      I=I + 1
      GO TO 70

C
C     PER ACRE CALCULATIONS AND TOTALS FOR STAND
C
   75 DO 90 I=1,5
      RV(I)=VOL(I)*NS(I)
          DO 80 J=1,7
          N(I,J)=NP(I,J)*NS(I)
   80     V(I,J)=N(I,J)*COST(J)
   90 CONTINUE
C
      DO 110 J=1,7
          DO 100 I=1,5
          NTOT(J)=NTOT(J) + N(I,J)
  100     VTOT(J)=VTOT(J) + V(I,J)
  110 CONTINUE
C
      DO 120 J=1,7
  120 VGT=VGT + VTOT(J)
C
      DO 130 I=1,5
  130 TOTRV=TOTRV + RV(I)
C
C     THESE INITIALIZATIONS WERE SPECIFIC TO OUR CONSTRAINTS
C     AND MAY NOT BE NEEDED
C
      NP(1,7)=0
      NP(2,7)=0
      DO 150 I=3,4
          DO 140 J=5,7
  140     NP(I,J)=0
  150 CONTINUE
      NP(5,5)=0
      NP(5,6)=0
C
C     WRITE THE OUTPUT FOR THE STAND
C
      WRITE(22,310) (NAME1(J),J=1,8),(NAME2(J),J=1,8),
     1(NAME3(J),J=1,8)
  310 FORMAT('1'//4X,'STAND EVALUATION --',4X,3(8A1)/
```

```
     14X,'GROSS PRODUCT POTENTIAL'//)
      WRITE(22,315)
  315 FORMAT(11X,'7-FT',5X,'13-FT',5X,'17-FT',5X,'21-FT',5X,'10-FT',
     15X,'PANEL',6X,'BARN',7X,'RES')
      WRITE(22,320)
  320 FORMAT(1X,'DBH',7X,'POST',3(6X,'RAIL'),6X,'PROP',2(6X,'POLE'),
     16X,'VOLUME')
      WRITE(22,325)
  325 FORMAT(1X,3('-'),2X,7(4X,6('-')),4X,7('-'))
      WRITE(22,330)
  330 FORMAT(10X,'PROD 1',4X,'PROD 2',4X,'PROD 3',4X,'PROD 4',
     14X,'PROD 5',4X,'PROD 6',4X,'PROD 7')
      WRITE(22,335)
  335 FORMAT(6X,7(4X,6('-'))/)
C
      DO 370 I=1,5
      K=I + 2
      WRITE(22,340) K,(N(I,J),J=1,7),RV(I)
  340 FORMAT(2X,I1,2X,'#',7(4X,I6),4X,F7.2)
      WRITE(22,350) (V(I,J),J=1,7)
  350 FORMAT(5X,'$',7(3X,F7.2)/)
  370 CONTINUE
C
      WRITE(22,380) (NTOT(J),J=1,7),TOTRV
  380 FORMAT(//1X,'TOT',1X,'#',7(3X,I7),3X,F8.2)
      WRITE(22,385) (VTOT(J),J=1,7)
  385 FORMAT(5X,'$',7(3X,F7.2))
      WRITE(22,390) VGT
  390 FORMAT(////5X,'TOTAL VALUE FOR STAND -- ',F7.2)
C
C     RECYCLE FOR ANOTHER STAND -- OR QUIT
      WRITE(6,395)
  395 FORMAT(/5X,'ANOTHER STAND? YES=1 OR NO=2 : ',$)
      READ *,IRUN
      IF(IRUN.EQ.1) GO TO 10
      END
C
      SUBROUTINE INFO(II,NPP,VOLL,NSS)
C
C           THIS SUBROUTINE QUERIES THE USER FOR THE INPUT
C           INFORMATION FOR A PARTICULAR STAND--IT DOES THIS
C           FOR EACH DBH CLASS
C
      COMMON NP(5,7),VOL(5),NS(5)
      K=II + 2
      WRITE(6,400) K
  400 FORMAT(/5X,'INPUT FOR ',I1,'-INCH CLASS')
      WRITE(6,410)
  410 FORMAT(7X,'ENTER 7 PRODUCT COUNTS SEPARATED BY COMMAS : ',$)
      READ *,(NP(II,J),J=1,7)

      WRITE(6,430)
  430 FORMAT(10X,'ENTER RESIDUAL VOL FOR ALTERNATIVE : ',$)
      READ *,VOL(II)

      WRITE(6,450)
  450 FORMAT(10X,'ENTER STEMS/ACRE FOR THIS DBH CLASS : ',$)
      READ *,NS(II)
      RETURN
      END
```

```
********************************
   WORKSHEET FOR PROGRAM 2
********************************

PRODUCT VALUES : VALUES THE USER ASSIGNS TO THE
                 7 PRODUCTS--MUST BE IN SAME ORDER AS
                 IN THE PRODUCT ALTERNATIVES
                X.XX,X.XX,X.XX,X.XX,X.XX,X.XX,X.XX

       WE USED : .52,.65,1.24,1.45,.50,.50,2.38


3-INCH CLASS    : AVERAGE TOTAL TREE HEIGHT=______
                  HEIGHT CLASS=______ (SEE BELOW)
                  ALTERNATIVE SELECTED=______
       PRODUCT COUNTS FOR CHOSEN ALTERNATIVE IN SAME ORDER
       AS PRODUCT VALUES-- X,X,X,X,X,X,X
            RESIDUAL VOLUME FOR ALTERNATIVE=______(X.XX)
            STEMS/ACRE FROM STAND TABLE=______(XXXX)

4-INCH CLASS    : AVERAGE TOTAL TREE HEIGHT=______
                  HEIGHT CLASS=______ (SEE BELOW)
                  ALTERNATIVE SELECTED=______
       PRODUCT COUNTS FOR CHOSEN ALTERNATIVE IN SAME ORDER
       AS PRODUCT VALUES-- X,X,X,X,X,X,X
            RESIDUAL VOLUME FOR ALTERNATIVE=______(X.XX)
            STEMS/ACRE FROM STAND TABLE=______(XXXX)

5-INCH CLASS    : AVERAGE TOTAL TREE HEIGHT=______
                  HEIGHT CLASS=______ (SEE BELOW)
                  ALTERNATIVE SELECTED=______
       PRODUCT COUNTS FOR CHOSEN ALTERNATIVE IN SAME ORDER
       AS PRODUCT VALUES-- X,X,X,X,X,X,X
            RESIDUAL VOLUME FOR ALTERNATIVE=______(X.XX)
            STEMS/ACRE FROM STAND TABLE=______(XXXX)

6-INCH CLASS    : AVERAGE TOTAL TREE HEIGHT=______
                  HEIGHT CLASS=______ (SEE BELOW)
                  ALTERNATIVE SELECTED=______
       PRODUCT COUNTS FOR CHOSEN ALTERNATIVE IN SAME ORDER
       AS PRODUCT VALUES-- X,X,X,X,X,X,X
            RESIDUAL VOLUME FOR ALTERNATIVE=______(X.XX)
            STEMS/ACRE FROM STAND TABLE=______(XXXX)

7-INCH CLASS    : AVERAGE TOTAL TREE HEIGHT=______
                  HEIGHT CLASS=______ (SEE BELOW)
                  ALTERNATIVE SELECTED=______
       PRODUCT COUNTS FOR CHOSEN ALTERNATIVE IN SAME ORDER
       AS PRODUCT VALUES-- X,X,X,X,X,X,X
            RESIDUAL VOLUME FOR ALTERNATIVE=______(X.XX)
            STEMS/ACRE FROM STAND TABLE=______(XXXX)

HEIGHT CLASSES DEFINED :
----------------------

        25 = 22.5-27.4          45 = 42.5-47.4
        30 = 27.5-32.4          50 = 47.5-52.4
        35 = 32.5-37.4          55 = 52.5-57.4
        40 = 37.5-42.4          60 = 57.5-62.4
```

Program 3—Computer Listing for Obtaining Net Product Estimates From Individual Tree Records

```
C     PROGRAM 3

C     ********************************************************
C     NET PRODUCT POTENTIAL FROM INDIVIDUAL PIECES AFTER ALL
C                 DEFECTS HAVE BEEN REMOVED
C         PROGRAMMER : J. SCHLIETER
C     ********************************************************

C     PROGRAM TO OBTAIN NET PRODUCT ESTIMATES FOR THOSE PIECES
C     REMAINING AFTER DEFECTS ARE ELIMINATED -- USER CAN SPECIFY
C     AT MOST 7 PRODUCTS AND WILL TYPE IN NAME, LENGTH, SMALL
C     DIAM SPECS, LARGE DIAM SPECS, PRODUCT VALUE -- USER MUST
C     DO SOME PRELIMINARY WORK TO CREATE THE DATA FILE NEEDED
C     FOR THIS ROUTINE!   (DETAILS FOLLOW THIS LISTING)

C     UNIT ASSIGNMENTS ARE :
C          UNITS 5,6 = USER CONSOLE      UNIT 21 = SCRATCH FILE
C          UNIT 20 = INPUT DATA FILE     UNIT 22 = OUTPUT FILE

      CHARACTER PROD(7)*10,PRODUCT*3,PRO*3,PIECE*3

      DIMENSION SPEC(7,6),SDBH(10),RESID(5),VALTOT(5),LASTPROD(20),NUM(7
     1),NPROD(7),IPR(5,7),PR(5,7),NP(5),BEG(10)
      REAL LDBH(10),LEN(10)
      INTEGER OLDALT(50,7)

      COMMON SPEC,LDBH,SDBH,LEN,NPROD,IPROD,ICT,RES,AST,LASTPROD,
     1NUMPROD,LASTCT,NUM,ICL,BEG
      COMMON /BK1/PRODUCT,PIECE

      OPEN(6,FILE='@CONSOLE')
      OPEN(20,FILE='DEFECT.DAT')
      OPEN(21,FILE='INTER.DAT')
      OPEN(22,FILE='NET.OUT',CARRIAGECONTROL='FORTRAN')

*******  INPUT PRODUCTS OR END PROGRAM  *******

    1 WRITE(6,2)
    2 FORMAT(///' Do you want to :(1)Input products  or (2)Quit ?')
      PRINT 500
  500 FORMAT('     ENTER 1 OR 2 : ',$)
      READ *,IN
      IF(IN.EQ.2) GO TO 1000
      IF(IN.NE.1) THEN
        WRITE(6,3)
    3   FORMAT(/'  You MUST enter a 1 or 2!  Try Again!'/)
        GO TO 1
      ENDIF

*******  QUERY FOR PRODUCTS AND THEIR SPECIFICATIONS  *******

      NUMPROD=0
      WRITE(6,4)
    4 FORMAT(///'  You can input up to 7 products and their specificatio
     1ns.'/'  The specifications are:'/'    -NAME'/'    -LENGTH'/'    -S
     2MALL diameter constraints -  min  and  max  constraint'/'    -LARG
     3E diameter constraints -  min  and  max  constraint'/'    -VALUE o
     4f product'//)
   10 NUMPROD=NUMPROD + 1
      IF(NUMPROD.GT.7) THEN
         NUMPROD=7
```

```
         GO TO 17
      ENDIF
      WRITE(6,11) NUMPROD
   11 FORMAT(//'    Enter Specifications for Product #',I1/)
      PRINT 505
  505 FORMAT('      ENTER PRODUCT NAME(10 CHAR OR LESS) : ',$)
      READ(5,12) PROD(NUMPROD)
   12 FORMAT(A10)
      IF(PROD(NUMPROD).EQ.'          ') THEN
        IF(NUMPROD.EQ.1) GO TO 1
        NUMPROD=NUMPROD - 1
        GO TO 17
      ENDIF
      PRINT 510
  510 FORMAT(5X,'ENTER PRODUCT LENGTH :',$)
      READ(5,*) SPEC(NUMPROD,1)
      WRITE(6,13)
   13 FORMAT(5X,'Enter SMALL Diameter Specifications:')
      PRINT 515
  515 FORMAT(8X,'MIN,MAX :',$)
      READ(5,*) SPEC(NUMPROD,2),SPEC(NUMPROD,3)
      WRITE(6,14)
   14 FORMAT(5X,'Enter LARGE Diameter Specifications:')
      PRINT 515
      READ(5,*) SPEC(NUMPROD,4),SPEC(NUMPROD,5)

******* ROUND-OFFS FOR OUR PRODUCTS MAY NOT BE NEEDED BY OTHERS
      SPEC(NUMPROD,1)=SPEC(NUMPROD,1) - .04
      SPEC(NUMPROD,2)=SPEC(NUMPROD,2) - .04
      SPEC(NUMPROD,4)=SPEC(NUMPROD,4) - .04
      SPEC(NUMPROD,3)=SPEC(NUMPROD,3) + .05
      SPEC(NUMPROD,5)=SPEC(NUMPROD,5) + .05

      PRINT 525
  525 FORMAT(5X,'ENTER PRODUCT VALUE :',$)
      READ(5,*) SPEC(NUMPROD,6)
      GO TO 10

*******  READ STAND INFO FROM DATA FILE
   17 READ(20,530,ERR=1000) ISTAND,NPLOT,BLOW
  530 FORMAT(2(I1,1X),F3.0)

      DO 6 I=1,5
         RESID(I)=0.0
         NP(I)=0
         VALTOT(I)=0.0
         DO 5 J=1,7
            IPR(I,J)=0
    5    CONTINUE
    6 CONTINUE
*******  READ INFO ON A DEFECTIVE PIECE -- RETURN HERE AFTER
*******  PRODUCT ALTERNATIVE DETERMINED FOR PIECE
   19 READ(20,535,ERR=250) ICL,DL,DS, B1,ALEN,AST,RESV
  535 FORMAT(I1,2(2X,F4.2),2(2X,F4.1),2X,F4.3,1X,F4.2)
      RES=0.0

C  INITIALIZE COUNTERS : ICL=DBH CLASS, ICT=UNUSED ARRAY COUNTER, IPROD=
C    PRODUCT #, NALT=# OF ALTERNATIVES/PIECE, NUMALT=COUNTER FOR OLDALT

      ICL=ICL - 2
      NP(ICL)=NP(ICL) + 1
```

```
      ICT=1
      IPROD=1
      NALT=0
      NUMALT=0

*******  PUT LOG INTO UNUSED ARRAY
*******      LDBH=LARGE END  SDBH=SMALL END  LEN=LENGTH
      LDBH(ICT)=DL
      SDBH(ICT)=DS
      LEN(ICT)=ALEN
      BEG(ICT)=B1

      PRODUCT='NO'
      PIECE='NO'
      DO 76 M=1,20
       LASTPROD(M)=0
   76 CONTINUE

      VAL=0.0
      DO 80 J=1,NUMPROD
         NPROD(J)=0
   80 CONTINUE

C CALL SUBROUTINE SCAN TO SEE IF PRODUCT FITS
   90 PRO='NO'
   95 CALL SCAN

*******     IF PRODUCT FIT, CALL SCAN AGAIN TO SEE IF ANY PRODUCTS
*******     WILL FIT IN LEFTOVER PIECE
  110 IF(PRODUCT.EQ.'YES') THEN
        IPROD=1
        PRODUCT='NO'
        PRO='YES'
        CALL SCAN
        GO TO 110
      ELSE
        IF(PRO.EQ.'YES') THEN
          IF(IPROD.EQ.NUMPROD) GO TO 200
          IPROD=IPROD+1
          GO TO 95
        ENDIF
      ENDIF

******* NEXT PRODUCT, BUT FIRST WRITE THE ALTERNATIVE OBTAINED
  200  IF(PRO.EQ.'NO') GO TO 235
         NUMALT=NUMALT+1
         VAL=0.0
         IF(RES.LT.0.0)RES=0.0
         DO 205 I=1,NUMPROD
           OLDALT(NUMALT,I)=NPROD(I)
           VAL=VAL+(FLOAT(OLDALT(NUMALT,I))*SPEC(I,6))
  205    CONTINUE
         IF(NALT.EQ.0) THEN
           NALT=NALT+1
           WRITE(21,210)NALT,(NPROD(I),I=1,NUMPROD),RES,VAL,NP(ICL)
  210      FORMAT(1X,8(I3,2X),2(F6.2,2X),I2)
         ELSE

C SEE IF ALTERNATIVE ALREADY EXISTS
           DO 220 J=1,NUMALT-1
             DO 215 I=1,NUMPROD
```

```
            IF(NPROD(I).EQ.OLDALT(J,I)) GO TO 215
            GO TO 220
  215     CONTINUE
          GO TO 235
  220   CONTINUE
        NALT=NALT+1
        WRITE(21,210)NALT,(NPROD(I),I=1,NUMPROD),RES,VAL,NP(ICL)
      ENDIF
    IF(ICT.GE.2) THEN
      IF(PRO.EQ.'NO') GO TO 235
      ICT=ICT-1
      J=LASTPROD(ICT)
      NPROD(J)=NPROD(J) - 1
       IF(ICT.EQ.1) THEN
        DO 226 J=1,NUMPROD
          NPROD(J)=0
  226   CONTINUE
      ENDIF
      IF(IPROD.GE.NUMPROD) GO TO 238
  235 IF(IPROD.GE.NUMPROD) THEN
        IF(ICT.EQ.1) THEN
         DO 236 J=1,NUMPROD
          NPROD(J)=0
  236    CONTINUE
      V2=0.0
      NALT=NALT + 1
      WRITE(21,210)NALT,(NPROD(I),I=1,NUMPROD),RESV,V2,NP(ICL)
         GO TO 238
        ENDIF
         J=LASTPROD(ICT-1)
         NPROD(J)=NPROD(J) - 1
         ICT=ICT-1
         IPROD=LASTPROD(ICT)+1
         IF(IPROD.GT.NUMPROD) GO TO 240
         IF(PIECE.EQ.'YES') THEN
           IF(ICT.LT.LASTCT) THEN
             PIECE='NO'

******* TAKE AWAY ALL PRODUCTS MADE FROM SPLIT LOG
             DO 237 K=1,NUMPROD
               NPROD(K)=NPROD(K) - NUM(K)
  237        CONTINUE
           ENDIF
         ENDIF
         GO TO 239
      ENDIF
  238 IF(PRO.EQ.'NO') THEN
         IPROD=IPROD+1
         IF(IPROD.GT.NUMPROD) GO TO 240
         GO TO 239
      ENDIF
      IPROD=LASTPROD(ICT)+1
  239 GO TO 90
    ENDIF

*******  CHOOSE ALTERNATIVE, UPDATE ICL ARRAYS, PREPARE TO READ
*******  INFO FOR NEXT PIECE
  240 REWIND 21
    V=0.0
    R=0.0
    DO 242 I=1,NALT
```

```
      READ(21,210)K,KP1,KP2,KP3,KP4,KP5,KP6,KP7,RES,VK,KK
      IF(ICL.GE.3 .AND. KP5.GT.0) GO TO 242
      IF(VK.EQ.0.0 .AND. K.EQ.1) GO TO 247
      IF(VK.EQ.V) GO TO 243
      IF(VK.LT.V) GO TO 242
      GO TO 244
  243 IF(RES.GT.R) GO TO 242
  244   KPR1=KP1
        KPR2=KP2
        KPR3=KP3
        KPR4=KP4
        KPR5=KP5
        KPR6=KP6
        KPR7=KP7
        V=VK
        R=RES
  242 CONTINUE

      IPR(ICL,1)=IPR(ICL,1) + KPR1
      IPR(ICL,2)=IPR(ICL,2) + KPR2
      IPR(ICL,3)=IPR(ICL,3) + KPR3
      IPR(ICL,4)=IPR(ICL,4) + KPR4
      IPR(ICL,5)=IPR(ICL,5) + KPR5
      IPR(ICL,6)=IPR(ICL,6) + KPR6
      IPR(ICL,7)=IPR(ICL,7) + KPR7
      RESID(ICL)=RESID(ICL) + R + RESV
      REWIND 21
      GO TO 19

  247 DD=(DL**2) + (DS**2)
      RX=.002727077*DD*ALEN
      RESID(ICL)=RESID(ICL) + RX + RESV
      REWIND 21
      GO TO 19

*******  SUMMARIZE STAND INFORMATION AND OUTPUT STAND SUMMARY
*******  TO UNIT 22
  250 PLOT=FLOAT(NPLOT)
      DO 260 I=1,5
         RESID(I)=(RESID(I)*BLOW)/PLOT
        DO 255 J=1,7
           PR(I,J)=IPR(I,J)*(BLOW/PLOT)
           IPR(I,J)=NINT(PR(I,J))
           VALTOT(I)=VALTOT(I) + (IPR(I,J)*SPEC(J,6))
  255   CONTINUE
  260 CONTINUE

      WRITE(22,270) ISTAND
  270 FORMAT('1'//5X,'STAND ',1X,I2,6X,'NET PRODUCT POTENTIAL FROM TREES
     1 WITH DEFECT')
      WRITE(22,275)
  275 FORMAT(20X,'ON PER ACRE BASIS USING MAX VALUE ALTERNATIVE'/20X,'FO
     1R EACH PIECE'///)
      WRITE(22,280)
  280 FORMAT(13X,'13 FT',1X,'17 FT',1X,'21 FT',7X,'PANEL',2X,'BARN')
      WRITE(22,285)
  285 FORMAT(1X,'DBH',3X,'POSTS',3(1X,'RAILS'),1X,'PROPS',2(1X,'POLES'),
     14X,'VOL',5X,'VALUE'/)

      DO 290 I=1,5
      WRITE(22,287)I+2,(IPR(I,J),J=1,7),RESID(I),VALTOT(I)
```

```
  287 FORMAT(2X,I1,5X,7(I3,3X),F6.2,3X,F6.2/)
  290 CONTINUE

      GO TO 17
 1000 STOP
      END

      SUBROUTINE SCAN

C          THIS SUBROUTINE SCANS FOR PRODUCTS

      CHARACTER PRODUCT*3,PRO*3,PIECE*3

      DIMENSION SPEC(7,6),DIVL(2),DIVS(2),DIVLN(2),SDBH(10),NUM(7),
     1LASTPROD(20),NPROD(7),BEG(10)

      REAL LDBH(10),LEN(10),L

      COMMON SPEC,LDBH,SDBH,LEN,NPROD,IPROD,ICT,RES,AST,LASTPROD,
     1NUMPROD,LASTCT,NUM,ICL,BEG
      COMMON /BK1/PRODUCT,PIECE

      ICLL=ICL + 2
      J=IPROD
      IF(J.EQ.6 .AND. LEN(ICT).EQ.17.) GO TO 375

C CHECK IF LARGE DIAMETER WITHIN PRODUCT SPECS
  370 IF((LDBH(ICT).LE.SPEC(J,5)).AND.(LDBH(ICT).GE.SPEC(J,4)))
     1THEN

C CHECK LENGTH TO SEE IF PRODUCT FITS
       IF(LEN(ICT).GE.SPEC(J,1)) THEN

C IF LENGTH EQUALS PRODUCT LENGTH, MAKE SURE SMALL DIAM IS LARGER
C THAN MINIMUM SMALL DIAM
        IF(LEN(ICT).EQ.SPEC(J,1)) THEN
          IF(SDBH(ICT).LT.SPEC(J,2)) GO TO 425
        ENDIF

C CALCULATE SMALL DIAM AT PRODUCT LENGTH
          D1=ICLL - ((SPEC(J,1)+BEG(ICT))*AST)
          IF(D1.LT.SDBH(ICT)) D1=SDBH(ICT)

C CHECK TO SEE IF SMALL DIAM WITHIN PRODUCT SPECS
          IF((D1.GE.SPEC(J,2)).AND.(D1.LE.SPEC(J,3))) THEN

C TAKE PRODUCT OUT OF PIECE
             LDBH(ICT+1)=D1
             SDBH(ICT+1)=SDBH(ICT)
             LEN(ICT+1)=LEN(ICT)-SPEC(J,1)
             R1=(D1**2) + (SDBH(ICT)**2)
             RES=.002727077*R1*LEN(ICT+1)
             BEG(ICT+1)=BEG(ICT) + SPEC(J,1)
             NPROD(J)=NPROD(J) + 1
             LASTPROD(ICT)=J
             ICT=ICT+1
             PRODUCT='YES'
             GO TO 600
           ELSE

C IF SMALL DIAM STILL TOO BIG, TAKE AWAY 1 FOOT AND TRY AGAIN
```

```
            IF(D1.GT.SPEC(J,3)) THEN
               LDBH(ICT)=LDBH(ICT)-AST
               LEN(ICT)=LEN(ICT)-1.0
               GO TO 370
            ENDIF
          ENDIF
       ENDIF
     ELSE

C CHECK TO SEE IF PIECE NEEDS TO BE DIVIDED -- IF SMALL DIAM GREATER
C THAN MAX LARGE DIAM OF PRODUCT, NO PRODUCT CAN BE MADE FROM PIECE
       IF(SDBH(ICT).GT.SPEC(J,5)) GO TO 425

C CHECK TO SEE IF LARGE DIAM GREATER THAN MIN LARGE DIAM
       IF(LDBH(ICT).GT.SPEC(J,4)) THEN

C CHECK LENGTH TO SEE IF IT FITS
         IF(LEN(ICT).GE.SPEC(J,1)) THEN

C DETERMINE LENGTH AT MAX LARGE DIAM -- SPEC(J,5)
           L=(LDBH(ICT)-SPEC(J,5))/AST
           IF((LEN(ICT)-L).LT.SPEC(J,1)) GO TO 425

C DIVIDE THE PIECE
           DIVL(1)=LDBH(ICT)
           DIVS(1)=SPEC(J,5)
           DIVLN(1)=L
           DIVL(2)=SPEC(J,5)
           DIVS(2)=SDBH(ICT)
           DIVLN(2)=LEN(ICT)-L

C CHECK AGAIN TO SEE IF PRODUCT WILL FIT
  400      IF((DIVL(2).LE.SPEC(J,5)).AND.(DIVL(2).GE.SPEC(J,4))) THEN
              IF(DIVLN(2).GE.SPEC(J,1)) THEN
                D1=DIVL(2)-(SPEC(J,1)*AST)
                IF((D1.GE.SPEC(J,2)).AND.(D1.LE.SPEC(J,3))) THEN
                  LDBH(ICT+1)=D1
                  SDBH(ICT+1)=SDBH(ICT)
                  LEN(ICT+1)=DIVLN(2)-SPEC(J,1)
                  R2=(D1**2) + (SDBH(ICT)**2)
                  RES=.002727077*R2*LEN(ICT+1)
                  NPROD(J)=NPROD(J) + 1
                  LASTPROD(ICT)=J
                  ICT=ICT+1
                  LASTCT=ICT
                  PRODUCT='YES'
                  GO TO 450
                ELSE

C IF LARGE DIAM TOO BIG, TAKE AWAY 1 FOOT AND TRY AGAIN
                  IF(D1.GT.SPEC(J,3)) THEN
                    DIVLN(1)=DIVLN(1)+1
                    DIVLN(2)=DIVLN(2)-1
                    DIVL(2)=DIVL(2)-AST
                    DIVS(1)=DIVL(2)
                    GO TO 400
                  ENDIF
                ENDIF
              ENDIF
            ENDIF
          ENDIF
```

```
        ENDIF
      ENDIF
  425 PRODUCT='NO'
      GO TO 600


******* CHECK FOR PRODUCT -- INITIALIZE THE NUMBER OF PRODUCTS
*******   TAKEN OUT OF PIECE

  450 J=1
      DO 460 K=1,NUMPROD
        NUM(K)=0
  460 CONTINUE
  475 IF((DIVL(1).LE.SPEC(J,5)).AND.(DIVL(1).GE.SPEC(J,4))) THEN
        IF(DIVLN(1).GE.SPEC(J,1)) THEN
          D1=DIVL(1)-(SPEC(J,1)*AST)
          IF((D1.GE.SPEC(J,2)).AND.(D1.LE.SPEC(J,3))) THEN

C TAKE PRODUCT OUT AND CHECK REMAINING PIECE FOR PRODUCTS

            R3=(D1**2) + (SDBH(ICT)**2)
            RES=.002727077*R3*DIVLN(1)
            PIECE='YES'
            DIVL(1)=D1
            DIVLN(1)=DIVLN(1)-SPEC(J,1)
            NPROD(J)=NPROD(J) + 1
            NUM(J)=NUM(J)+1
            GO TO 475
          ENDIF
        ENDIF
      ENDIF
      J=J+1
      IF(J.GT.NUMPROD) GO TO 600
      GO TO 475

C SPECIAL CASE FOR PANEL POLE WHEN LENGTH IS EXACTLY 17
  375 LDBH(ICT+1)=LDBH(ICT)
      SDBH(ICT+1)=SDBH(ICT)
      LEN(ICT+1)=0.0
      RES=0.0
      PRODUCT='YES'
      NPROD(J)=NPROD(J) + 1
      LASTPROD(ICT)=J
      ICT=ICT + 1

  600 RETURN
      END
```

```
*********************************************
  NOTES ON DEFECT DATA FILE NEEDED IN ORDER
     TO RUN PROGRAM 3
*********************************************


FOR EACH STAND
--------------
   FIRST LINE WILL HAVE : STAND NUMBER, NUMBER OF PLOTS,
         PLOT BLOW-UP FACTOR (2(I1,1X),F3.0)

   DATA LINES WILL HAVE : DBH CLASS, LARGE END DIAM, SMALL
         END DIAM, BEGINNING LENGTH, LENGTH OF PIECE, STEM
         TAPER, RESIDUAL VOLUME
        (I1,2(2X,F4.2),2(2X,F4.1),2X,F4.3,1X,F4.2)

   LAST LINE WILL HAVE : 9

LAST LINE OF DATA FILE WILL HAVE : 999

STEM TAPER
----------
   DBH CLASS 3 : 1/(MERCH LENGTH - 1)

   DBH CLASS 4 AND 5 : 2/(MERCH LENGTH - 1)

   DBH CLASS 6 AND 7 : 3/(MERCH LENGTH - 1)

LARGE AND SMALL END DIAMETERS
-----------------------------
   DL = DBH - (LENGTH FROM BUTT END)(TAPER)

   DS = DBH - (LENGTH FROM BUTT END)(TAPER)

RESIDUAL VOLUME
---------------
   COMPUTE THIS FOR THE DEFECTIVE PARTS OF EACH STEM
   USING THE FORMULA :

      V = (.002727077)(DL**2 + DS**2)(LENGTH)

EXAMPLE
-------
   5 INCH DBH CLASS WITH MERCHANTABLE LENGTH 30 FEET
     WHICH HAS CROOK FROM 0-2 AND FROM 27-30

          SCHEMATIC :

             5   DL                    DS    3
             /////_____________________//////
            0    2                    27    30


   TAPER = 2/29 = .069

   DL = 5 -(2*.069) = 4.86
   DS = 5 -(27*.069)= 3.14

   RESIDUAL VOL = .133 + .154 = .29
```

SAMPLE DATA FILE

```
2 7 100
3  2.75  2.00   3.0  10.0  .083   .09
3  2.60  2.33   6.0   4.0  .067   .37
3  2.90  2.00   2.5  22.5  .042   .07
3  2.89  2.00   2.0  17.0  .056   .05
3  3.00  2.31   1.0  15.5  .042   .22
4  3.00  2.00   9.0  10.0  .111   .55
4  3.76  2.00   3.0  23.0  .080   .16
4  3.85  2.00   2.0  25.0  .077   .08
4  3.80  2.00   2.5  23.5  .080   .12
4  3.89  2.00   1.5  27.5  .071   .04
5  4.86  3.14   2.0  25.0  .069   .29
5  4.48  3.00   5.5  16.5  .095   .55
5  5.00  3.94   1.0  16.0  .063  1.07
5  5.00  3.59   1.0  18.0  .074   .54
5  4.88  3.00   2.0  33.0  .059   .13
6  6.00  5.27   1.0   8.5  .077   .00
6  5.83  3.00   2.5  42.5  .068   .29
7  6.83  4.00   2.5  42.5  .068   .39
9
999
```

SAMPLE OUTPUT FOR ABOVE DATA FILE

STAND 2 NET PRODUCT POTENTIAL FROM TREES WITH DEFECT ON PER ACRE BASIS USING MAX VALUE ALTERNATIVE FOR EACH PIECE

DBH	POSTS	13 FT RAILS	17 FT RAILS	21 FT RAILS	PROPS	PANEL POLES	BARN POLES	VOL	VALUE
3	0	0	0	0	14	29	0	22.26	21.50
4	0	0	0	0	43	43	0	22.92	43.00
5	71	14	43	0	0	0	0	45.57	99.34
6	57	0	0	14	0	0	0	8.00	49.94
7	14	0	14	0	0	0	14	7.57	57.96

*U.S. GOVERNMENT PRINTING OFFICE: 1989-0-673-039/81009

Schlieter, Joyce A.; Hawkins, Charles H., III. 1989. Estimating commercial product potential in small-stem lodgepole pine: methods, products, values. Gen. Tech. Rep. INT-255. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 58 p.

Presents a procedure to assess commercial potential using conventional stand-table or cruise plot information. Includes a stem profile table, tables of alternative gross product mixes, gross/net product potential, as well as defect summaries for nine sample stands, and general computer routines.

KEYWORDS: forest management, wood products, timber management, timber harvesting

a/

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